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THE ELECTRIC LIGHT AND POWER PLANT OF BRIGHAM CITY, UTAH.

By W. P. Hardesty,* C. E.

During the past few years a number of the towns located in the rural districts of Utah, which had heretofore been non-progressive, have awakened to the desirability of possessing the simpler public utilities. First among these to be established is usually an adequate water-works system, to supply pure water for domestic purposes and also as a protection against fire; second is an electric lighting plant, for supplying light for houses and streets.

Most of the towns and cities of Utah are so well situated that the creation of either of these improvements is comparatively simple and cheap. The sites for nearly all the earlier settlements were chosen in the neighborhood of the mouths of the canyons through which the streams pass before debouching into the valleys below. Such a location allows a short and direct diversion of the water onto the lands to be irrigated, and is characteristic. Possibilities for the development of excellent water powers exist in most of these canyons, as the fall through them is usually quite rapid, and this feature and the supply of pure water join in making possible the construction of water-works and of lighting plants at very reasonable costs.

Brigham City is located at the foot of the west slope of the Wasatch Range, near the mouth of the canyon of Box Elder Creek, and is 21 miles north of Ogden. The city has a population of about 3,000. It was settled about a half century back.

FIG. 1. GENERAL VIEW OF BOX ELDER CANYON AT SITE OF BRIGHAM CITY ELECTRIC LIGHT AND POWER PLANT.

(Looking Northeasterly, Shows Power House, Pressure Pipe and More Than Half of the Wood Stave Pipe Line.)

The water-works system was built some years ago. During 1902 and 1903 the electric light and power plant to be described was erected.

The mouth of Box Elder Canyon is located about 1¾ miles east of the center of the city. The fall through the canyon is rapid, amounting to about 250 ft. to the mile. The minimum flow of the creek is about 20 sec.-ft. The length of the canyon is about 2½ miles, above which it opens out into a mountain valley, which is taken up by farms.

The power plant was built and is owned and operated by the city. The funds provided for erection were not sufficient for a plant to utilize the entire fall through the canyon, so the choicest portion of the length was selected for the development. The system consists, essentially, of (1) a wood stave pipe for diverting water from the creek and carrying it along the canyon side; (2) a pressure or drop pipe of riveted steel, for conveying the water from the end of the wood pipe down to the power house; (3) the power station, for development of the water power and electric power; (4) the transmission line to the city, including the distributing system in the city. The plant is located on the north side of the canyon. A general view of the canyon and works is shown by Fig. 1.

WOOD STAVE PIPE LINE.—A diverting dam and intake is placed at the head of the pipe line. The structure is of wood, with gates of redwood, as shown by Fig. 2. The gates (Fig. 3) are raised and lowered by 2-in. screw stems operated by hand wheels. Part or all of the water of the creek can be turned into the pipe, according to the stage. The cost of the head works complete was $575.

The wood pipe (Figs. 4 and 5) begins here, and follows the general route of a supported grade line down the north side of the canyon. Its alinement is unusually direct, compared with most wood pipe lines of this size built in a canyon. The sharpest curves are of 20°, and there are only seven curves on the line. On this account much of the pipe is considerably below a hydraulic grade line. All changes of grade are made with vertical curves of long radius. There was some rather heavy trench work and considerable rock excavation in places.

The pipe has a diameter of 30¼ ins. and is of Oregon fir. The staves were milled from 2 × 6-in. stock, and are 1½ ins. thick by 5 ins. wide on the inside. The bands are of ½-in. diameter. In place of separate shoes or couplers for uniting the ends of the band there is made a drop forged coupler, one end of it shaped into a stub of a band of the proper size. The coupler is, through this stub, electrically welded to the band, and is termed the "head" of the band. The other end of the band is threaded. It is not upset, but consists of a separate piece of ⅝-in. rod. The threads are cut on this, and it is then electrically welded to the main band. The matter of threads is a mere detail, however, and having them rolled on an upset end answers equally as well. This plan of having the band and coupler in one piece has proved efficient, and it is more simple than the ordinary construction.

The spacing of the bands varies from 12 ins. (for all heads not exceeding 25 ft.) to 3 11-16 ins., the latter for a head of 106 ft. The bands are coated with asphaltum.

The butt joints of the staves are made tight by tongues, inserted in sawkerfs. These are of No. 12 galvanized iron, 1½ ins. wide, and ¼-in. longer than the width of the stave. The length of wood pipe is 5,750 ft. Of this 5,700 ft. was let in a contract for the lump sum of $11,694. The contract included building the pipe in place.

The excavation of the trench (including grading for a change in the wagon road, on account of the location of the pipe) cost $3,900. It was done by day labor.

The wood pipe was extended 50 ft. farther than first intended. This is at the lower end, where the head is greatest. The cost of this portion was $225.

For air connection at the two main summits on the line it was thought best not to rely on the somewhat uncertain action of air valves. Instead of these there is placed at each summit an 8-in. vent pipe, shown by Fig. 6, which leads up the hillside from the main pipe to a point above the static level (that of the surface of the water at the intake). Water rises in this to a height dependent on the hydraulic grade line, but immediate connection with the air is afforded when the pipe begins emptying. The pipe for the vents is of No. 16 galvanized iron, with the joints both

*228 Commercial Club Building, Salt Lake City, Utah.

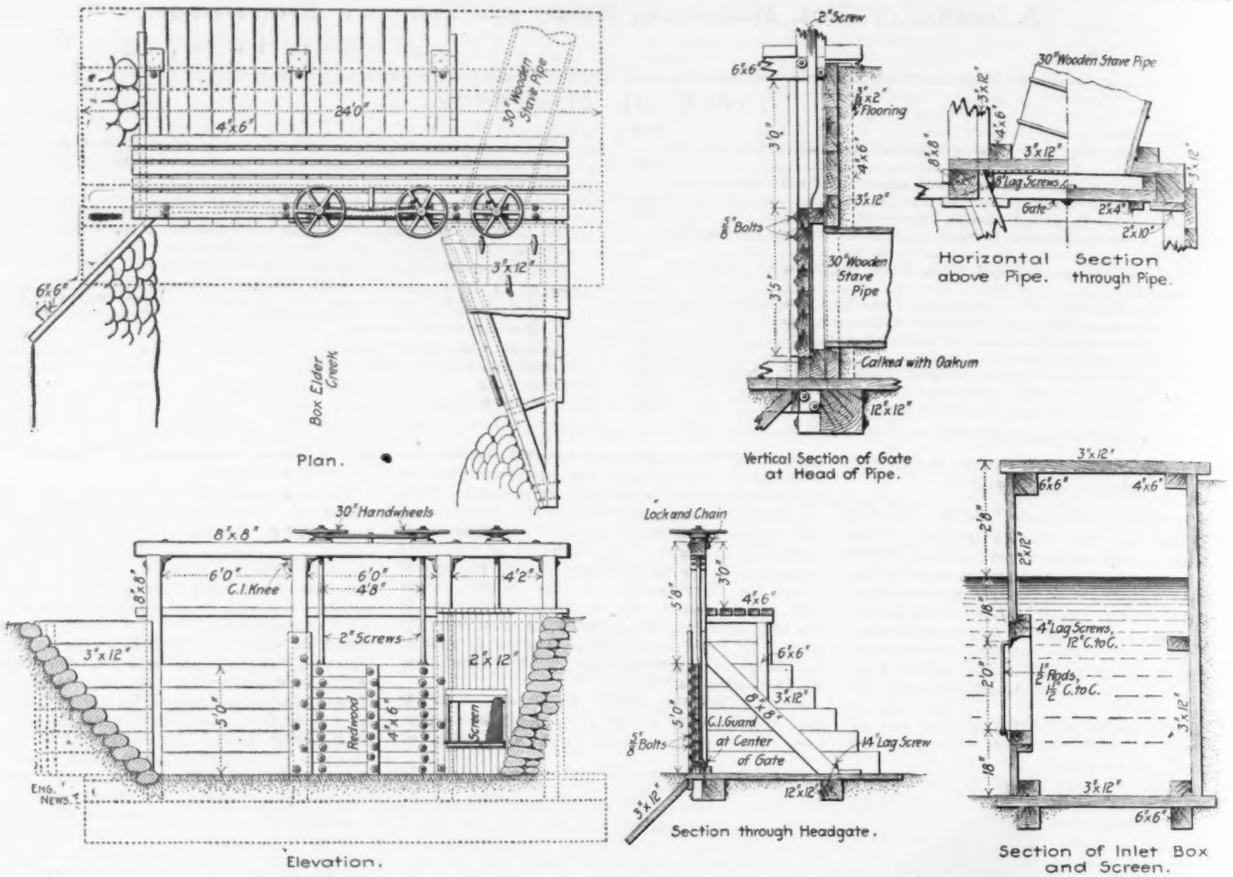


FIG. 2. DIVERTING DAM AND INTAKE, BRIGHAM CITY ELECTRIC LIGHT AND POWER PLANT.

riveted and soldered. The connection to the pipe is made by means of a cast-iron saddle. The cost of the two vent pipes was $78, to which is to be added the item of labor in putting them in. Each pipe is about 35 ft. long.

The section of pipe from the head to the second summit (5,000 ft.) controls the rate of flow through the pipe. With a hydraulic grade of 0.25% the calculated discharge is 25 sec.-ft.; with a grade of 0.50% the discharge is 35 sec.-ft., and this is the capacity for this section.

STEEL PRESSURE PIPE.—The steel pipe connects with the wood pipe where the static head is 106 ft. The pipe is of steel plate, with longitudinal seams double-riveted and circular seams single-riveted. The first 200 ft. is of 3-16-in. plate; then follows 198 ft. of ¼-in. plate, at the foot of which is the Y-branch of ⅜-in. plate. The total length of 403.6 ft. cost $2,432, erected in place. The contractor was the American Bridge Co. The trench work was done by the city.

The pipe was laid on a grade of 62.44%, the slope being 32°. Two concrete anchorages (Fig. 7) are provided, one half-way down the slope, and the other at the foot. The first one is built in four steps, carried to the rock ledge on the hillside. It has a horizontal length of 20 ft. The one at the vertical bend at the foot of the hill has a length of 24 ft. The junction of the wood and the steel pipe is made by means of a special cast-iron hub, calked with wooden wedges, shown by Fig. 8.

The actual total length of the wood pipe and steel pipe is 6,152 ft., and the horizontal length is 6,100 ft.

POWER HOUSE AND EQUIPMENT.—The power station is built at the bottom of the canyon on the north side of the creek. The building, shown in plan and section by Fig. 9, is of brick on rubble masonry foundations, the latter being carried up to about 4 ft. above ground, to the window sills. The inside dimensions are 23 × 40 ft. The building cost $1,700, not including plastering.

The cost of the concrete foundations for the water wheel and generator, the concrete tailrace (about 70 ft. long), the concrete around the "Y" at the lower end of the steel pipe, the two concrete anchorages for the pipe, together with the excavations for the foregoing aggregated about $1,600. The work was done by day labor.

The water power is developed by means of a Pelton double water wheel. The wheel has a 7-in. forged steel shaft (6 ins. at the bearings), with ball and socket bearings of the generator type, oil-ring bearings for oiling, housing of steel plate riveted to cast-iron flanges, and base of cast-iron of the same construction as that for the generator.

The diameter of the wheel is about 60 ins. Water is supplied to either of the two wheels by a taper pipe. The two taper pipes are attached to the Y and are 20 ins. in diameter at the larger end and 12 ins. at the smaller one. They are 8½ ft. long, and have flanges on each end. Their cost in place was $195.

The nozzles for discharging water onto the wheel buckets are attached to the tapers. They are of three sizes, ranging from 2 to 3⅛ ins.

The static head at the wheel is 302 ft. The maximum degree of efficiency of the wheel is attained when using 20 sec.-ft. The effective head is then 290 ft., and the horse-power developed 527. The speed is 300 revs. per min. The wheel can generate 800 HP., with a sufficient supply of water. The guaranteed efficiency is 80%. The contract price of the wheel, including base, housing, etc., and the valves at connections between the nozzles and the tapers, and also the Lombard governor, was $3,520, f. o. b. at San Francisco. In this the governor was delivered at Brigham City. The wheels discharge into a concrete tailrace, which leads on a 2.5% grade to the creek, about 70 ft. distant.

There is a 12-in. waste pipe leading downwards from the main steel pipe just back of the Y, by

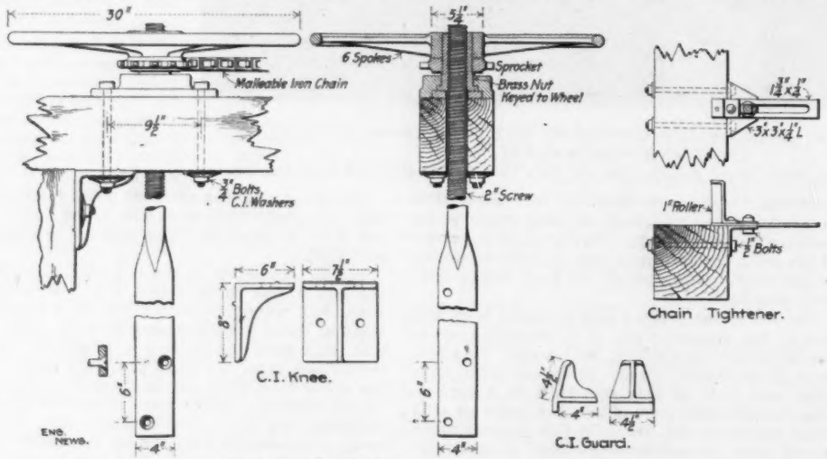


FIG. 3. IRONWORK FOR GATES FOR DIVERTING DAM.

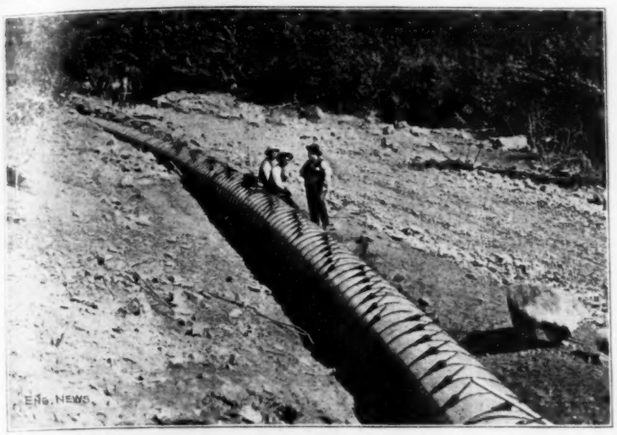


FIG. 4. VIEW OF WOOD STAVE PIPE LINE NEAR HEAD.

which the pipe can be emptied into the tailrace without passing the water through the wheels.

The wheels are direct-connected to the generator. The coupling is a leather-link coupling. This consists of a number of solid leather links about 16 ins. long. Projecting from a disk or face plate (one at the end of the generator shaft and the other at end of the water-wheel shaft) on either side the coupling are a number of steel studs, placed near the circumference. Each link is attached to a stud on either side, and collectively they form the coupling. This forms a very flexible coupling, one that does not require a rigid or precise lining up of the two shafts.

The generator is a 350-KW., 300 revs., 60 cycles, 3-phase, 2,400-4,150-volt alternator. The generator is Y-connected; that is, there are four wires placed so as to form the four points of the figure Y. There are the three outside conductors or active wires at the terminals of the legs, while the neutral wire is at the junction at the center.

The voltage between active wires is 4,150; that between the neutral wire and any one of the active wires is 2,400. When the load is balanced there is no current through the neutral wire. There is a slight current when the load is unbalanced. The exciter is a direct-current, 11-KW., 1,300-revs. machine. The voltage is 125 at full load and 120 without load. It is driven by belt from a pulley on the generator shaft.

The electrical machinery and apparatus installed at the power house cost $6,500. The current is transmitted to town at the initial voltage of 4,150. There are four No. 6 bare copper wires mounted on glass insulators. The poles are spaced 132 ft. apart. From the station to Main St., in town, the distance is 9,500 ft. Here the distribution begins. With a full load it is figured that the voltage may reduce in the transmission to about 4,000. There are primary circuits of four wires (4,150-2,300 volts), and those of two wires (2,300 volts). The secondary circuits are of three wires (230-115 volts), and of two wires (115 or 230 volts). Current for power is carried at 230 volts, and that for lighting (both arc and incandescent) at 115 volts.

The transformers are usually placed three blocks apart, the secondary wires running 1½ blocks each way. The arc lights are used for lighting the two most traveled streets of town. On the other streets 50-c.p. incandescent lights are used, one at each corner of an intersection. Up to May 1, 1905, there had been put in use 30 arc lights and 100 of the others. There were also about 1,400 lights used by private consumers, ranging from 8 to 32 c.p.

The monthly charges for lights are as follows: For 16 c.p., 50 cts. for the first light, and 25 cts. for each additional one; for 8 c.p., 25 cts. for the first and 15 cts. for each additional; for 32 c.p., $1 for the first and 50 cts. for each additional. The service is unlimited, as the lights may be on the full 24 hours. Power is sold at the low figure of $2 per HP. per month for day service. In the accounting of the lighting service the municipal corporation as well as private parties are charged for the lights.

The plant began running on Nov. 15, 1903. By May 1, 1905, the service had grown to the size stated. The gross revenues amounted to $745 per month, and the net earnings to about $500. The service was being steadily extended for power, and a line was being built to a small neighboring town for supplying it with light. The operation of the system cost about $240 per month. Nearly all of this was for wages. There are but three men regularly employed.

The cheapness of power has led to its introduction for a variety of purposes. In town there are several small establishments that use small induction motors. The most important and beneficial application of power is in the operation of small pumping plants for irrigation purposes. There has long been a scarcity of water for irrigation around Brigham City. Nearly the sole dependence has been on Box Elder Creek. So admirably are the soil and climate adapted for fruit growing (Brigham is the most noted fruit-growing section in the State) that development of late has had to wait on an increased supply of water. A good supply can be found anywhere in the ground by digging from 12 to 35 ft.

Several centrifugal pumps that have been put in use have demonstrated the profit in pumping the water for irrigation. These are driven by 10-HP. motors. The test of one in 1904 showed that the cost of pumping from a depth of 20 ft. to supply a tract of 40 or 50 acres amounted to only about $1.50 per acre for the season. The annual tax for maintenance and operation of the canals in the same neighborhood is $1.25 per acre. As the ownership of a water right is required for this, while the underground water costs nothing, the advantage is apparent. Practically the only cost of operation is the $20 per month for the power. The irrigator turns the regulator to set the motor and pump in motion, and no further attention is needed. A 10-HP. motor, with compensator, costs here about $225. The motor is belt-connected with the pump at the bottom of the well. A No. 3 pump is ordinarily used, with 3-in. discharge and 4-in. suction. The demand for water for use in maturing late crops, such as sugar beets, is very great here, as well as in some other parts of Utah, and a man controlling his own supply is quite independent.

The plant was designed and built under the supervision of Mr. Frank C. Kelsey, who was for a number of years city engineer of Salt Lake City. The plan of making the band and shoe for banding the wood stave pipe in one piece was invented by Mr. Kelsey. The total cost of the

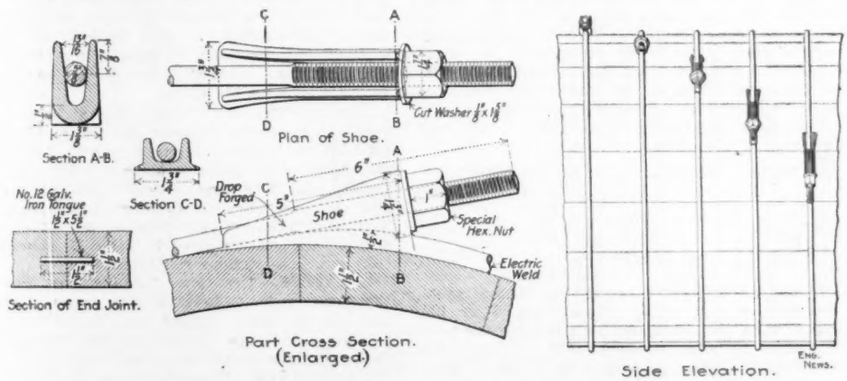


FIG. 5. DETAILS OF WOOD STAVE PIPE.

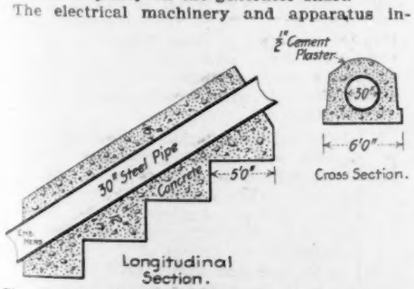


Fig. 7. Concrete Anchorage for Steel Pressure Supply Pipe on Slope and at Foot of Hill.

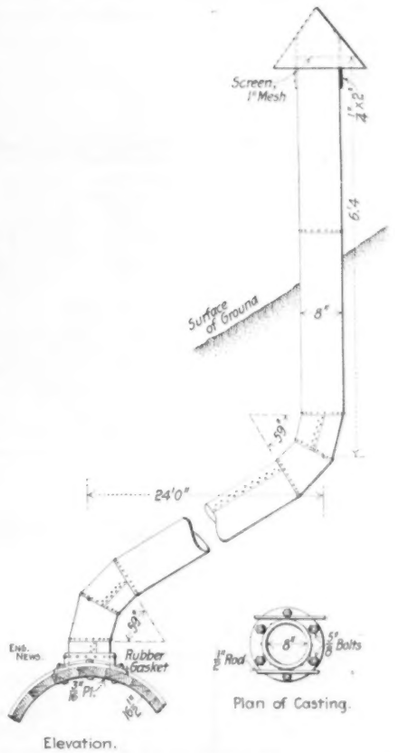


Fig. 6. Galvanized Iron Vent Pipe at Summits of Wood Stave Pipe Line.

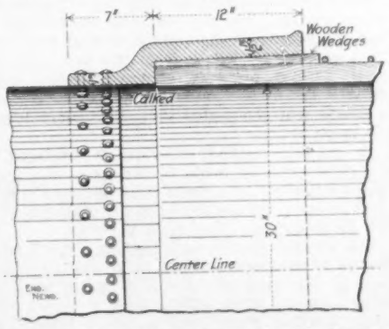


Fig. 8. Cast Iron Hub for Connecting Steel Pressure Supply Pipe with Wood Stave Pipe.

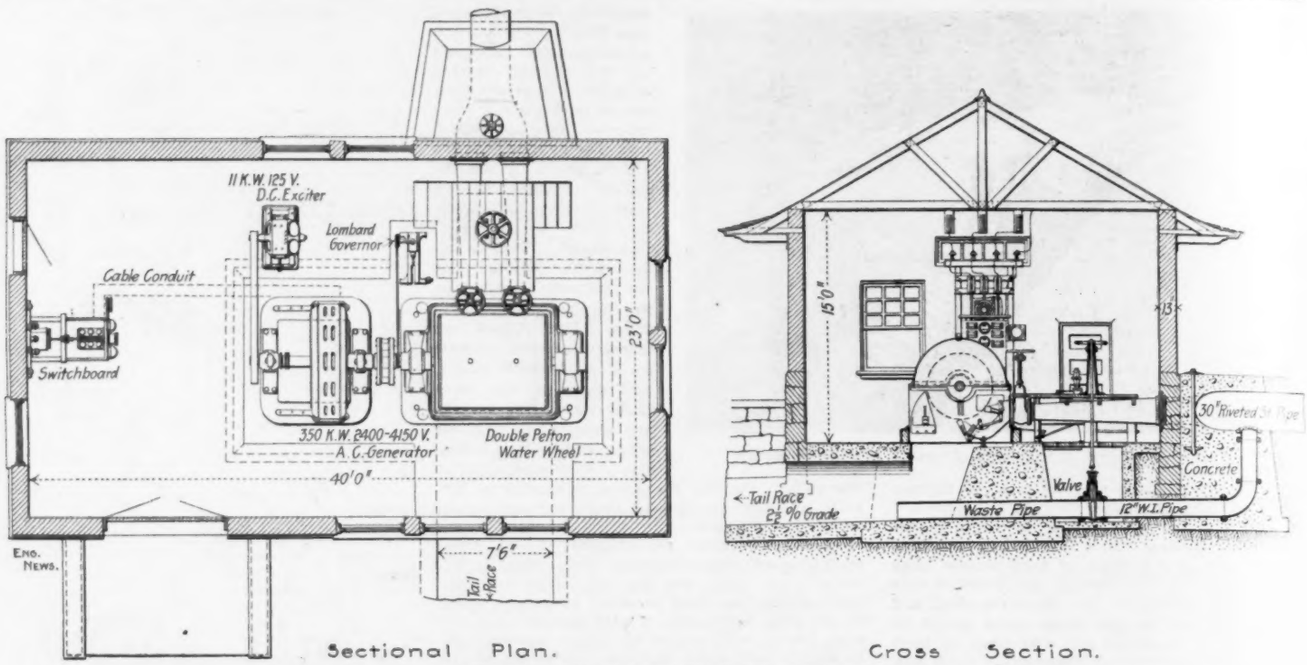


FIG. 9. BRIGHAM CITY HYDRO-ELECTRIC POWER HOUSE.

plant and distribution system, including items of all kinds, up to May 1, 1905, was about $47,000. The cost of the main parts of the development has already been given.

Since the construction of this pipe line Mr. Kelsey has devised an entirely new method of making the butt joints of the staves. This consists (see Fig. 10) of a malleable casting, of the same curvature as the pipe, and with its length the same as the width of the stave. This has two flanges on either side, to fit snugly over the outside and inside of the end of each stave, while they abut against the web connecting the flanges. The flanges lap over some distance on the adjoining staves. This joint has been used on other pipe lines by Mr. Kelsey, who has patented it, and it has proved very efficient.

SPECIFIC GRAVITY AND WEIGHT OF BUILDING STONE, CEMENTS, AND OTHER NON-METALLIC STRUCTURAL MATERIALS.

By Edwin C. Eckel,* Assoc. Am. Soc. C. E.

The tables of weight per cubic foot and specific gravity of various materials which are given in engineering pocket-books and trade catalogues are usually based upon English data of questionable accuracy, and of very ancient date. This is the more unfortunate because, with regard to the non-metallic structural materials particularly, a large number of accurate determinations of these constants are available. In the present article an attempt has been made to present reliable data on the specific gravity and weight per cubic foot of various classes of building stones, and also of plasters, limes and cements.

The results attained by different experimenters, unfortunately, are not directly comparable unless the details of the testing method are known. This uncertainty arises from the fact that three very distinct methods of determinating specific gravity are in use, and that these three general methods will often give very different values for the same stone.

In the first method, the stone is powdered, and the determination made by means of the specific gravity bottle. The value thus obtained is really that of the particles of the stone, exclusive of the air contained between these particles.

The second, or Gillmore method, used I believe at the Watertown Arsenal, is to weigh the specimen in air, then immerse it in water until bubbling ceases, after which it is removed, dried with blotting paper and again weighed. This method removes part of the air, but usually not very much. Drying the stone at 212° F., previous to immersion, increases its accuracy.

The third method is to weigh the stone in air, and then in water as quickly as possible, giving it no time to become saturated. This method should, of course, give lower values than either of the two preceding, for it does not dispose of the air included between the particles of the stone.

Hopkins has presented data which will serve to give some idea of the differences that may exist in the values given by the three methods. These data are tabulated in Table I. for convenience of comparison:

TABLE I.—Specific Gravity by Different Methods

	Method 1	Method 2	Method 3
Specimen 1.....	2.66	2.35	....
Specimen 2.....	2.63	2.35	....
Specimen 3.....	2.68	2.36	....
Specimen 4.....	2.65	....	2.48
Specimen 5.....	2.65	....	2.46

It will be seen that, for the specimens tested, the first method gives values from 6 to 12% higher than those obtained by the other methods. It should be said, however, that all the specimens were porous stones; a very dense stone would not have given so great a variation.

The first method is the only completely satisfactory one, from a scientific point of view. But the third gives values which are usually of more service to the engineer, for on multiplying the specific gravity so obtained by 62.4, we obtain the weight per cubic foot of the stone as it will be used, air spaces and all. The specific gravity values determined by the first method, if similarly multiplied, would give the weight per cubic foot of the stone if it could be obtained in an absolutely dense condition—a condition in which stone never occurs.

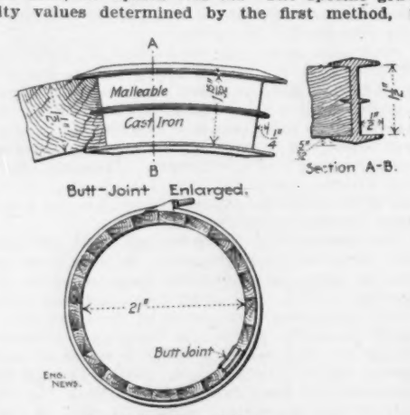


Fig. 10. Detail of Malleable Iron Fitting for Butt Joints in Wood Stave Pipes.

In the tables following values obtained by the first method are marked A; those obtained by the second method, B; and those of the third method, C. Omission of these letters indicates that the exact method followed was not stated in the original publication.

TRAPS.—The term "trap" is used by quarrymen and engineers to cover the heavy, dark colored, close textured igneous rocks. The traps are usually dark green to black in color, are very tough, and little used except as broken stone. For this last purpose, however, they are peculiarly valuable. The determinations of weight and specific gravity given in Table II. have been collected from various reliable sources.

GRANITES.—The term "granite," as used in the stone trade, includes all the coarser grained and usually light colored igneous rocks, commonly lower in specific gravity than the "traps." Table II. gives weight and specific gravity.

SANDSTONES.—The sandstones consist essentially of grains of sand held together by iron oxide, lime carbonate or some other natural cementing material. As a group the sandstones are fairly well defined, but they vary greatly among themselves in density, porosity, and coarseness of grain, all of which exert a marked influence on the apparent specific gravity. Table II. gives the weights and specific gravity of various sandstones.

SLATE.—Aside from a series of determinations on the roofing-slates of the New York-Vermont belt, few satisfactory data have been published in the specific gravity and weight of slates: Such as are available are given in Table II.

LIMESTONES.—Taken as a geological class, limestones show very great variations in weight per cubic foot. When the investigation, however, is restricted to those limestones which are sufficiently dense and solid to be suitable for building stones, the limits of variation are much closer. Table II. gives weights and specific gravity of limestone.

MARBLE.—The materials commercially known as marbles are usually crystalline limestones which will take a satisfactory polish and are of pleasing color. The specific gravity and weights of various marbles are given in Table II.

PLASTERS.—The structural materials which are included in the groups of plasters are marketed under different names, according to slight differences in methods of manufacture, properties and uses. The principal products of this group are plaster-of-Paris, stucco, "cement plas-

*U. S. Geological Survey, Washington, D. C.

TABLE II.—Showing Specific Gravity and Weight per Cubic Foot of Various Natural Rocks in Common Engineering Use.

State	Locality	Spec. Grav.	Wt. per cu. ft.
	Trap Rock		
Minnesota	Duluth	2.80	174.7
"	"	3.00	187.2
"	Taylor's Falls	3.00	187.2
New Jersey	Jersey City	3.03	189.1
"	Little Falls	2.99	188.5
New York	Staten Island	2.86	178.5
	Granite		
California	Penrhyn	2.77	172.7
"	Rocklin	2.68	167.3
Connecticut	Greenwich	2.84	177.3
"	New London	2.66	166.0
"	Stone Mountain	2.69	167.9
Georgia	Lithonia	2.69	167.9
Maine	Hallowell	*B* 2.65	165.3
Maryland	Port Deposit	2.72	169.7
Massachusetts	Quincy	2.70	168.5
New Hampshire	Keene	2.66	166.0
New York	Grindstone Island	*B* 2.71	169.1
"	Keeseville	*B* 2.76	171.7
"	Westerly	2.67	166.6
Rhode Island	Barre	2.65	165.4
Vermont	Amberg	*B* 2.71	169.1
Wisconsin	Montello	*B* 2.64	164.8
	Sandstone		
Colorado	Fort Collins	2.43	151.6
"	Trinidad	2.34	146.0
Connecticut	Portland	*B* 2.63	163.8
"	"		
Massachusetts	Longmeadow	*B* 2.49	155.1
Michigan	Portage Entry	*B* 2.54	158.2
Minnesota	Fond du Lac	*C* 2.24	139.8
New Jersey	Belleville	*B* 2.56	159.7
New York	Albion	*B* 2.60	162.1
"	Medina	*B* 2.58	161.1
"	Hulberton	*B* 2.41	150.4
"	Potsdam	*B* 2.60	162.3
"	Oswego	*B* 2.62	163.6
"	Malden	*B* 2.75	171.5
"	Oxford	*B* 2.71	169.0
"	Portage	*B* 2.70	168.0
"	Warsaw	*B* 2.68	167.1
"	Olean	*B* 2.60	162.0
Ohio	Berea	*B* 2.57	160.1
"	"	*C* 2.14	133.6
"	Cleveland	*C* 2.21	137.9
"	Massilon	*C* 2.11	131.7
Pennsylvania	Hummelstown	*A* 2.66	166.1
"	Lumberville	*A* 2.60	162.5
Virginia	Bristow	*B* 2.61	162.4
	Slate		
New York	Middle Granville	*B* 2.84	177.0
"	Granville	*A* 2.78	173.5
"	"	*A* 2.81	175.3
Vermont	Rutland	*A* 2.79	174.1
"	"	*A* 2.76	171.6
Cornwall, England		2.81	175.3
Silesia, Austria		2.75	171.6
	Limestone		
Illinois	Joliet	2.56	159.7
"	Lemont	2.51	156.6
"	Quincy	2.57	160.3
Indiana	Bedford	2.48	154.7
"	Salem	2.51	156.6
Kentucky	Bowling Green	*B* 2.70	168.0
Minnesota	Frontenac	2.63	164.1
"	Winona	2.67	166.6
New York	Canajoharie	*B* 2.73	169.9
"	Cobleskill	*B* 2.71	169.1
"	Glens Falls	*B* 2.72	169.4
"	Kingston	*B* 2.69	167.8
"	Prospect	*B* 2.72	169.8
"	Sandy Hill	*B* 2.76	172.3
"	Williamsville	*B* 2.71	168.5
	Marble		
Georgia	Tate	2.73	170.8
New York	Gouverneur	*B* 2.76	171.8
"	Pleasantville	*B* 2.87	178.9
"	Tuckahoe	*B* 2.87	178.7

ter," Keene's cement, and Parian cement. They are all made by driving off part of the water naturally contained in the mineral gypsum, which is a hydrous sulphate of lime corresponding to the chemical formula $C_a S O_4 + 2 H_2 O$. In the process of plaster manufacture three-fourths of the water contained in gypsum is driven off, so that the resulting plaster corresponds in chemical composition to the formula $C_a S O_4 + \frac{1}{2} H_2 O$.

A pure gypsum, before being burned, has a specific gravity of 2.30 to 2.33, which corresponds to a weight of about 143½ lbs. per cubic foot. A lump of burned plaster has an apparent specific gravity of only 1.81, corresponding to a weight of about 113 lbs. per cubic foot. This low apparent gravity is due to the porosity of such a lump, for the true specific gravity of plaster, in powder, is about 2.57.

After burning, plasters are powdered before marketing, and when used for structural purposes are usually mixed with sand as well as water. A recent determination on a Western plaster gave a weight of 64 lbs. per bushel, in powder; and a block composed of 1 part sand and 2 parts plaster, after being allowed to set and dry, gave an apparent specific gravity of 1.5, corresponding to a weight of 93½ lbs. per cu. ft.

From the above data it will be seen that all the plasters are light in weight, and this is one of the advantages which they possess, when compared with lime, for use on walls, ceilings, etc.

LIME.—Freshly burned lime ("quicklime") in powder has a true specific gravity of 3.09 to 3.15, but its apparent specific gravity is so much less that as packed, in lumps, it will weigh only about 60 lbs. per cu. ft. The specific gravity of slaked lime is about 2.08, corresponding to a weight of 130 lbs. per cu. ft.

LIME-SAND BRICKS.—A recent renewal has been experienced by this industry, which first flourished in this country about 1840. Carefully made specimens of lime-sand brick have shown a weight as high as 130 to 140 lbs. per cu. ft., while more porous samples fall as low as 100 lbs. per cu. ft.

MAGNESIA AND MAGNESIA BRICKS.—Magnesia ($M_g O$) is produced by burning the mineral magnesite, a carbonate of magnesium ($M_g C O_3$). If the magnesite be burned quickly at a comparatively low temperature the resulting magnesia will be light, with a specific gravity of 3.00 to 3.07; but if the burning be at a high temperature, or long continued, the product will be a denser magnesia with a specific gravity of 3.60 to 3.80. Magnesia bricks are made from a mixture of both light and dense magnesia, and in consequence are intermediate in specific gravity; giving a weight of 160 to 170 lbs. per cu. ft.

NATURAL CEMENTS.—One of the most persistent errors in engineering literature is in relation to the specific gravity of natural cements, the usual statement being that this varies between the limits of 2.5 to 2.8. As a matter of fact very few American natural cements fall as low as 2.8, while it would be a physical impossibility to burn a cement in such a way as to give a specific gravity of 2.5. This can be readily understood when it is recollected that the cement rock, before burning, has a specific gravity of 2.6 or over, and that the burned product can never be lower in specific gravity than the original rock.

TABLE III.—Specific Gravity of American Natural Cements.

State	Locality	Authority	Sp. gr.
Illinois	Utica	C. Richardson	2.70
Kansas	Fort Scott	"	2.79
Maryland	Cumberland	Philadelphia, 1897	2.90
"	"	" 1899	2.85
"	"	" 1899	2.83
"	"	Watertown, 1899	2.94
"	Round Top	C. Richardson	2.84
"	"	Philadelphia, 1899	2.92
Minnesota	Austin	Watertown, 1901	3.15
"	Mankato	" "	2.93
"	"	C. Richardson	2.81
New York	Rosendale	"	3.04
"	"	Watertown, 1901	3.03
"	"	" "	3.06
"	"	" "	3.03
"	Akron	" "	3.07
"	"	" "	3.12
"	"	Philadelphia, 1897	3.17
Pennsylvania	Lehigh	" 1897	3.06
"	"	" 1899	2.96
"	"	" 1897	2.97
"	"	" 1897	3.07
"	"	" 1899	3.02
"	"	Watertown, 1901	2.85

The average of this series of 24 determinations is 2.96; and this may be accepted as a fair average value for the specific gravity of American natural cements. In putting limiting values in specifications or definitions, it will be advisable to set 2.7 and 3.2 as the minimum and maximum, respectively, for any closer limits would bar out very meritorious products.

PORTLAND CEMENT.—The specific gravity of Portland cement may range from 3.0 to 3.2, depending largely on degree of burning.

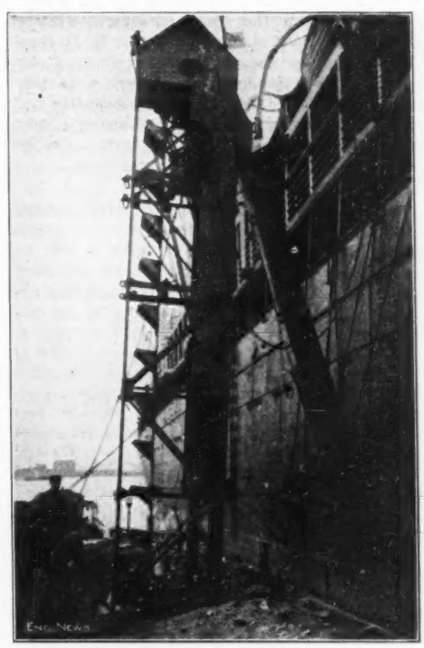
SLAG-CEMENT.—Slag cement, which is simply a lively ground mechanical mixture of slag and slaked lime, will naturally fall lower in specific gravity than Portland cement, which is burned heavily during manufacture. Tests of several American brands of slag cements, made some years ago at Philadelphia, showed the following results:

Brand	Specific gravity
Toltec	2.861
Climax	2.888
Penn	2.831

It is interesting to note that the only specifications for slag cement so far issued—those of the Engineer Corps, N. S. Army—state that the specific gravity of this product must fall within the limits of 2.7 to 2.8. It would be far better to give 2.7 and 2.9 as limits, for a lower maximum is simply placing a premium on the free use, by the manufacturer, of lime and water. Slag-cement is doubtful enough anyway, without forcing the manufacturers to supply a particularly poor product.

CONVEYING APPARATUS FOR COALING STEAMERS.

Facilities for coaling steamers are an important item in the equipment of large ports, and it is frequently necessary to do the work as rapidly as possible, but generally the work is done under difficulties incident to the lack of machinery specially adapted to the purpose. The accompanying illustration represents a new coal handling plant designed for this particular service, and now in use at New York. An elevating conveyor with buckets carried by link-belt chains is mounted in a light steel frame about 30 ft. high, which is suspended by tackle from a boom fitted to a socket in the ship's side, and supported by guy ropes or stays. The lower end or boot of the conveyor is in the coal barge, and men with shovels feed the coal to the boot and shift the barge or lower the frame as the coal is unloaded. At the top of the frame the buckets dump their contents into a chute having an adjustable shoe which enters the bunker port in the side of the vessel. A canvas can be attached to the frame to prevent the nuisance from coal dust. The conveyor is driven by an electric motor of 8 HP., current for which is taken from the ship. There are 30 steel buckets, each holding about 1 cu. ft. (or about 36 lbs.) of coal. The total weight is about two tons, and the machine can be set up, moved and removed by four men. Three or four machines are used at one time, each with six men, including the shovelers in the barge and the trimmers in the bunkers.



Machine for Coaling Steamers at the Pier of the American Line, New York.

(At "A" is shown the foot of the boom from which the conveyor is suspended.)

These coaling machines are used by the American Line. We are informed that they have handled an average of 60 tons an hour each, for 16 hours, delivering the coal to the bunkers of the steamers "St. Paul," "St. Louis," "Philadelphia" and "New York." They could deliver a greater quantity per hour but owing to the limited space in which the coal is received and to the necessity of keeping the bunkers trimmed no greater quantity can be received on board. With these machines the steamers mentioned have been coaled in 16 hours, while by the old method with buckets and a steam hoist on the barge only about 15 tons per hour could be handled by each hoist, and the time occupied was 30 to 36 hours.

The machine is the invention of Mr. L. A. de Mayo, who has recently organized the de Mayo Coaling Co., Pier 14 (new), North River, New York, N. Y. The conveyor is adapted to the handling of sand, gravel, ore, etc.

A SYSTEM OF SAFEGUARDS AGAINST FREEZING IN CONCRETE BUILDING CONSTRUCTION.

The vital necessity of absolute soundness in reinforced concrete beams and columns renders essential the most thorough precautions against frost when building is done in winter. This truth is fully realized by the more experienced builders in reinforced concrete, and they have given the subject of safeguards against freezing during construction very careful thought. To exemplify the extent and the expense of the precautions deemed justifiable in important work, we illustrate and describe here the means adopted to prevent damage by frost in constructing the shops of the Foster-Armstrong Piano Co., at Rochester, N. Y. These buildings were constructed during the severe winter of 1904-5 at temperatures often below zero, and the methods of protection adopted proved entirely successful. The same methods have also worked successfully in other buildings, and notably in the construction during the past winter of the addition to the works of the Pacific Borax Co., at Constable Hook, N. J. They have been developed as the result of several winters' work on important structures by Mr. E. L. Ransome, Assoc. Am. Soc. C. E., under whose design and supervision the buildings named were constructed. We are indebted to Mr. Ransome and his assistant engineer, Mr. F. V. Lawrence, who worked out the details of the apparatus, for the information from which this description has been prepared.

The new works of the Foster-Armstrong Piano Co. comprise six main buildings of which one is two stories high and 80 × 450 ft. in plan, with an 80 × 120-ft. wing; and five are duplicate five-story buildings 50 × 200 ft. in plan. The general arrangement of these buildings is shown by the diagram plan Fig. 1. They are all built entirely of reinforced concrete in which the Ransome twisted bars were used. The total floor area in these buildings was nearly half a million square feet. The system of safeguards against freezing comprised: (1) the preparation of the concrete materials so as to delay the action of frost, (2) the housing in of the work under construction and (3) the artificial heating of the enclosed space.

PREPARATION OF CONCRETE INGREDIENTS.—The preparation of the concrete ingredients comprised the heating of the sand and gravel and the addition of salt to the mixing water so as to lower its freezing point. These are both time-honored expedients, and the only point of novelty in their use here is in the character and management of the plant adopted for handling the large quantities of materials used daily. The daily consumption of sand and gravel was about 50 cu. yds. and 100 cu. yds., respectively.

To provide storage for the sand and gravel a bin

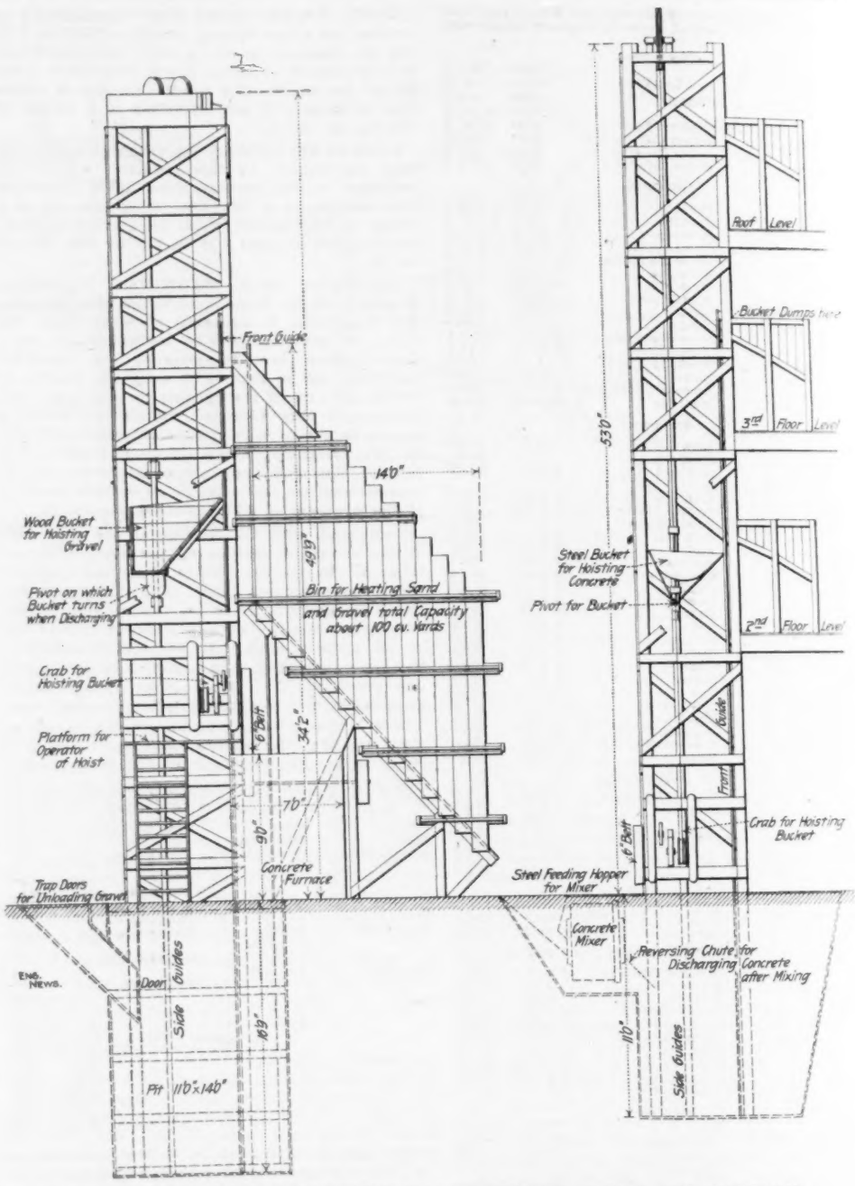


FIG. 2. DIAGRAM SHOWING ARRANGEMENT FOR STORING, MIXING AND HANDLING CONCRETE MATERIALS, FOSTER-ARMSTRONG PIANO WORKS.

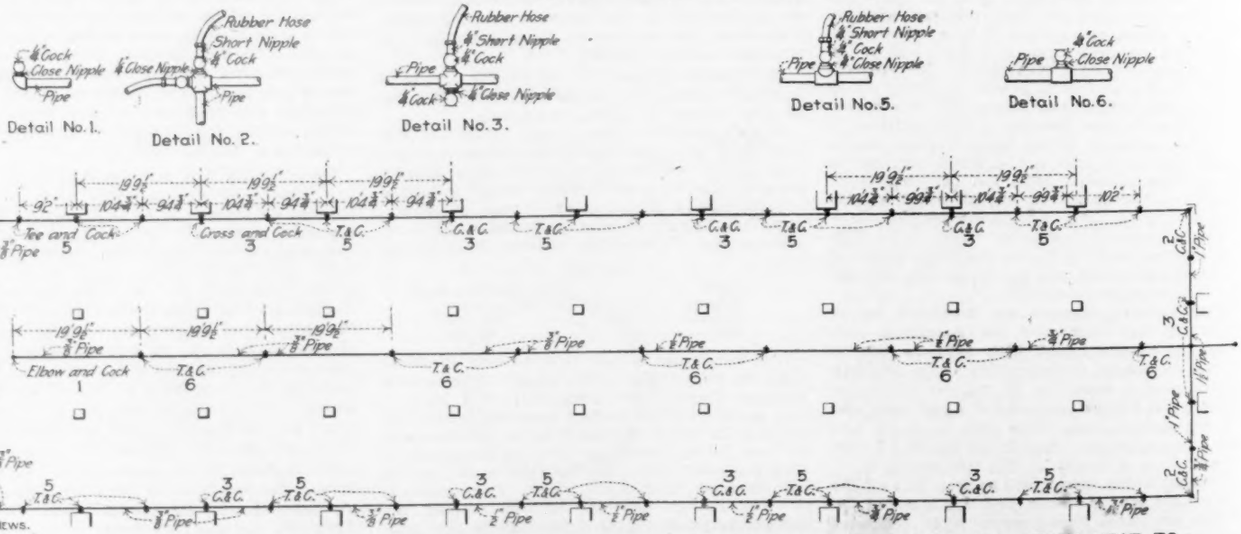


FIG. 1. DIAGRAM OF FOSTER-ARMSTRONG PIANO WORKS, SHOWING SYSTEM OF PIPES FOR CONVEYING STEAM HEAT TO BUILDINGS DURING CONSTRUCTION.

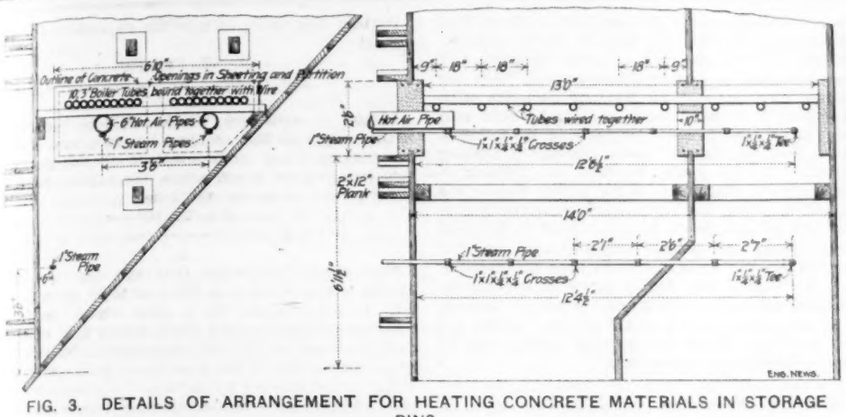


FIG. 3. DETAILS OF ARRANGEMENT FOR HEATING CONCRETE MATERIALS IN STORAGE BINS.

16 ft. square in projected plan was constructed with vertical sides and a sloping bottom, as shown in Fig. 2. This bin was thoroughly braced by interior struts and was divided by a vertical partition into a large and a small compartment for gravel and sand, respectively. These materials coming to the work are dumped by means of a chute into a wooden bucket which moves up and down in a guide frame located at the rear of the bin. The bucket is hoisted by means of a crab and is so hung out of balance that when hoisted clear of the restraint of the front guide, it dumps automatically. The front guide, as will be seen, is discontinued just above the bin top so that when it overturns the contents discharge into the bin.

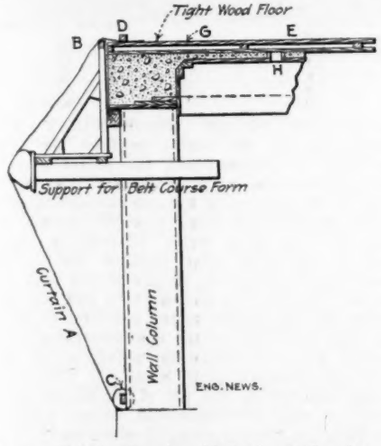


Fig. 4. Sketch Showing Method of Housing in Successive Stories of Buildings During Construction.

The heating of the sand and gravel is done within the storage bin, and the drawings of Fig. 3 show the arrangements devised for this purpose. The platforms or gratings of tubes set close together and supported, as shown, caused V-shaped cavities to be formed beneath in the gravel and sand. Into these cavities penetrated through one end of the bin pipes from a hot-air furnace and from a steam boiler. The hot-air pipes merely pass through the wall, but the steam pipes continue hearly to the opposite side of the bin and are provided with open crosses at intervals along their length. Where the pipes penetrate the wall and partition, concrete slabs are inserted. In addition to the conduits described there is a small pipe for steam located below and near the bottom of the bin. The hot-air pipes connect with a small furnace and air was forced through them by a Sturtevant No. 6 blower. The arrangement described sufficed although the top of the bin was open to snow and wind, to keep the gravel and sand from freezing.

The drawings of Fig. 2 show the relation of the gravel and sand bins to the concrete mixer. In mixing the concrete the water was heated to about 90° F. and salt added in about the proportion of 6 lbs. per barrel of cement. The water was heated by blowing live steam through perforated pipes in the storage tanks. There were two of these, each of 1,000 gallons capacity, one was used for fresh water and one for a saturated solution of salt water. The storage tanks discharged into a measuring tank which fed the salt water to the mixer. The method of taking the concrete from the mixer to the several floors of the building is indicated by Fig. 2. The mixer was a Ransome No. 3, and its output was 150 cu. yds. per day.

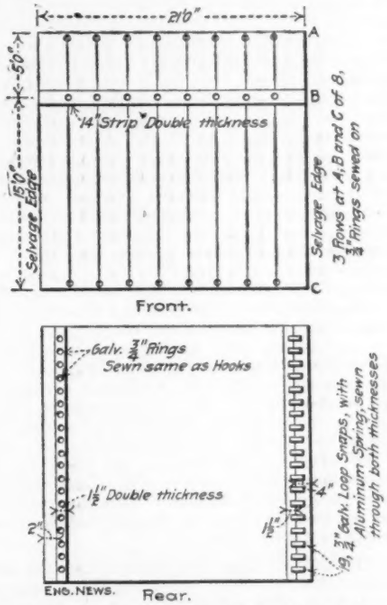


Fig. 5. Details of Canvas Curtains for Enclosing Side Walls.

HOUSING OF CONCRETE WORK.—Each building as it was constructed was housed in by a temporary structure of timber and canvass. The character of the protecting structure and the method of erecting it are best explained by referring to the sketches, Figs. 4 to 6. Fig. 4 shows one of the first floor wall columns and a portion of the second floor wall girders and floor system. It will be seen that the open sides are enclosed by canvass curtains and the floor covered with timber shutters. The curtain, A, Fig. 4, is held by tying-rings to a continuous string piece, B, the upper portion, or flap, D, being held down by a metal rod or other heavy object so as to lap over the floor covers, E. At the bottom the curtain is attached to the string piece, C. The sketch shows how the curtain adjusts itself to irregular projections such as the support for the belt course forms; to prevent the canvas from tearing on the timbers these are cushioned by rolls of bagging or other suitable material. The drawings of Fig. 5 show the fabrication of the individual curtains so clearly as to demand no description.

The construction of the wooden floor panels is shown by Fig. 6. They are so designed that a hollow space is left between them and the floor. To provide for a circulation of air in this space, holes are formed through the concrete floor slab as shown at H, Fig. 4. The drawing, Fig. 6, shows a 10 × 10-ft. panel, made of 12 × 1 in. boards nailed to the edges of 2×3 in. battens, the free edges of which have attached 6 × 1-in. boards to stiffen the ribs and give a good bearing on the green concrete.

HEATING THE INCLOSED SPACE.—The heating of the space inclosed by the housing was accomplished by means of coke fires in braziers and by a system of steam pipes from a central boiler. The plan, Fig. 1, shows the location of the boiler and the steam pipes which lead from it to the several buildings. Fig. 7 shows the arrangement of the steam piping in one of the buildings; this system was duplicated for each floor.

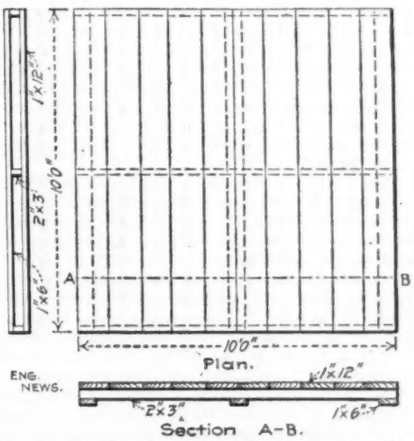


Fig. 6. Details of Wooden Panels for Covering Floors.

The idea of the arrangement is to discharge live steam into the inclosed space and into the hollow wall columns by means of short lengths of hose entered into holes in the column shells. The details of the various connections are shown by the drawings. The open fires were scattered throughout the floor area and were simply fires of coke in home-made braziers of reinforcing metal. Each brazier held about 5 cu. ft. of coke and ten of them were used for each inclosed floor 50 × 200 ft. × 13 ft. high. The ten braziers and the steam

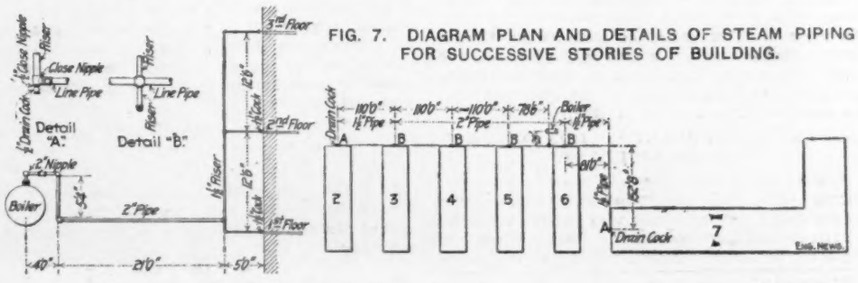


FIG. 7. DIAGRAM PLAN AND DETAILS OF STEAM PIPING FOR SUCCESSIVE STORIES OF BUILDING.

piping together kept the temperature at about 80° F. in the space below the floors, and at about 40° in the space between the floor top and its board covering. These temperatures were maintained when the temperature outside ranged from zero to 10° above zero.

In construction the columns were concreted first and then the belt courses and the floor system. As soon as the belt courses were completed the canvass wall curtains were hung, and likewise the floors were covered with the wooden panels as fast as the concreting was finished. The concrete was deposited regardless of the temperature, it being the theory that once laid, and whether frozen or not, it would be kept continually above freezing temperature by the artificial heating arrangements until it had thoroughly set. The theory worked out perfectly and no damage resulted to any of the work because of frost.

ENGINEERS AND CONTRACTORS.—As above stated, Mr. E. L. Ransome designed and superintended the construction of the six buildings for the Foster-Armstrong Piano Co. Mr. F. V. Lawrence, as assistant engineer, worked out the details of the plant and methods used. The contractors were Ransome and Smith Co. of New York city.

ECONOMY OF GAS-PRODUCER POWER PLANTS WHERE HEATING IS NECESSARY.

By J. H. Kinealy.*

In the preliminary report on the operations of the Coal Testing Plant of the Geological Survey, at St. Louis, Mo., we find on page 17 as a statement of one of "the results already clearly indicated" by the preliminary tests the following: "As indicated by comparative tests of 14 bituminous coals from 9 states, the power efficiency of these coals when used in the gas-producer is two and one-half times greater than their efficiency when used in the steam boiler plant; or, in other words, 1 ton of these coals used in the gas-producer plant has developed, on a commercial scale, as much power as 2½ tons of the same coal when used in the ordinary steam-boiler plant."

This statement means that the preliminary tests have shown that for power purposes a gas-producer plant will use only 40% of the fuel that would be used by the ordinary steam plant to develop the same power. It is well to bear in mind, while considering this statement, that what those in charge of the tests called an "ordinary steam boiler plant," was a steam plant in which the engine was a non-condensing engine of the Corliss type whose water rate was 26.3 lbs. of steam per hour per horse-power developed.

The boiler plant and the gas-producer plant were each of between 200 and 250 HP. capacity, and we are told on page 118 of the report that the "labor required would be the same for the operation of either the boiler plant or the gas-producer plant of the capacity under tests. In either plant two men would be sufficient." This means that the difference in the costs of operation of the two plants is equal to the difference in the cost of fuel alone.

In general, fuel for any establishment, whether a factory or not, is used for power purposes and for heating; and the relative cost of the fuel used for each depends upon the purpose of the establishment and upon its location. For most places in the United States north of the Ohio River it is usually necessary to provide heat for heating purposes for a season of about six months. Therefore, when considering the relative cost of fuel for a steam plant and a gas-producer plant for a given establishment, we may say that, for one half of the year fuel must be used for power only, and for the other half of the year fuel must be used for power and for heating.

GAS PRODUCER PLANT VS. NON-CONDENSING STEAM PLANT.

When the power plant is a non-condensing steam plant, the weight of fuel required for power and heating depends very largely upon the relative amounts required for each. When the quantity of steam required for power is greater than that required for heating, the weight of fuel required for heating will be practically nothing; because by the use of a properly designed and installed heating system exhaust steam from the engine may be used for heating purposes with very little or no back pressure being brought onto the engine, and hence with little or no increase in the fuel required for power during the heating season. If the steam required for heating is greater than that required for power during the winter, then the fuel for power during the winter need not be considered, because all of the exhaust steam from the engine supplemented by live steam from the boilers, will be used for heating, and the engine will simply serve as a reducing pressure valve for such steam as passes through it before entering the heating system. Hence the fuel required during the heating season will be that required for heating only.

We see, therefore, that for the ordinary non-condensing steam plant we have two cases to consider.

(1) When the steam required for power is greater than that required for heating. Here the fuel required during the heating season is what would be required for power only.

(2) When the steam required for heating is greater than that required for power. Here the fuel required during the heating season is what would be required for heating only.

When a gas producer-plant is used for power, the weight of fuel used during the winter is the sum of that required for power and that required for heating, because there seems to be no way as yet of using the exhaust from the gas engine for heating purposes. Hence when a gas-producer plant is used for power a separate steam plant must be installed for heating purposes. This means, of course, that if the steam plant required for heating purposes is large, more men may be required than would be required for the power plant alone; and the charges for labor for the operation of a combination plant consisting of a gas-producer plant for power and a steam plant for heating may be greater than the labor charges of a steam plant for both power and heating. However, we will here confine ourselves to a consideration of the difference in cost of fuel.

Let us suppose that the fuel required for power only will be the same during the warm half as during the cold half of the year. Further let x represent the weight of fuel required during one half of the year by the steam plant for power only; y, the weight of fuel required during the cold half of the year for heating, and n the ratio of the weight of fuel required for power by the gas-producer plant to the weight of fuel required for power by the steam plant. Then the weight of fuel required for power by the gas-producer plant for one half year is nx.

EXHAUST STEAM EXCEEDS HEATING REQUIREMENTS.—Now, considering the case of a non-condensing steam plant where the steam required for heating is less than that required for power, we have that the weight of fuel used during the heating season for both heating and power is equal to that required for power only, or it is equal to x. And, hence, the weight of fuel required for one year by the non-condensing steam plant is 2x. The weight of fuel required for power during the warm half of the year by the gas-producer plant is nx, and the weight of fuel required during the cold half of the year for both power and heating is nx + y. Hence the total weight of fuel required by the gas-producer plant for one year is 2nx + y. The saving in fuel per year effected by the use of a gas-producer plant instead of a steam plant of the non-condensing type would be 2x — 2nx — y. If c represents the per cent. of saving in fuel caused by the use of a gas-producer plant instead of a steam plant of the non-condensing type, we have

$$c = \frac{(2x - 2nx - y)\,100}{2x}.$$

Since the supposition is that the steam required for heating alone is *less* than that required for power alone, or y is less than x, we may say

$$y = x\,(1 - m).$$

Where m is a fraction less than unity.

Putting this value of y in the expression for c we get

$$c = \frac{(1 - 2n + m)\,100}{2}.$$

If now m were zero, which would be the case if the weight of fuel required by the steam plant for heating alone were equal to the weight of fuel required for power alone, the expression for the per cent. of saving would be

$$c_1 = \frac{(1 - 2n)\,100}{2}.$$

This expression shows that the per cent. of saving is zero when n is 0.5, and is 10 when n is 0.4. In other words, for a plant where the fuel requirements for heating alone during half of the year are equal to the fuel requirements for power alone during half of the year, there is no economy at all in fuel effected by the use of a gas-producer plant instead of a non-condensing steam engine plant when the gas-producer plant would use only half the fuel for power that the steam plant would; and there is an economy of only 10% when the gas-producer plant would use 0.4 the fuel for power that the steam plant would. As an offset to this 10% saving of fuel effected by the gas-producer plant must be put the interest and depreciation on the excess of cost of the gas-producer plant with its attending heating plant over the steam plant, and, also, probably a greater cost of labor during the heating season for the gas-producer plant with its attending heating plant.

The tabulation below shows the per cent. of saving effected by a gas-producer plant as compared to a non-condensing steam plant for n equal 0.4 and different values of m, when the steam required for heating is not greater than that required for power during one half the year.

m.	Per cent. of saving, c.
0.0	10
0.2	20
0.4	30
0.6	40
0.8	50
1.0	60

EXHAUST STEAM INSUFFICIENT FOR HEATING.—If the steam required for heating alone is greater than the steam required for power alone or y is greater than x, we have the second case of the non-condensing steam plant where the fuel required during the half of the year when heating is necessary is equal to that required for heating alone. In this case the weight of fuel used during the warm half of the year is x, and that used during the cold half is y; and the total weight of fuel used in a year by the non-condensing steam plant is x + y. As before, the weight of fuel used by the gas-producer plant is 2nx + y. The saving in fuel effected by the use of the gas-plant instead of the non-condensing steam plant is x — 2nx; and the per cent., c^1, of saving is

$$c^1 = \frac{x\,(1 - 2n)\,100}{x + y}.$$

If we let y equal $x\,(1 + m^1)$, where m^1 may have any positive value, the expression for c^1 becomes

$$c^1 = \frac{(1 - 2n)\,100}{2 + m^1}.$$

This expression for c^1, the per cent. of saving in fuel effected by the use of a gas-producer plant instead of a non-condensing steam plant where the fuel required for heating alone is greater than that required for power alone, shows that c^1 has its greatest value when m^1 is zero; and also that if n is equal to 0.5, c^1 is zero. In other words, there is no saving at all unless the fuel required for power alone by the gas-producer plant is less than one half of that required by the non-condensing steam plant for power alone.

When m^1 is zero the expression for c^1 is

$$c^1 = \frac{(1 - 2n)\,100}{2}.$$

And when n is equal to 0.4 as determined by the experiments at St. Louis, c^1 becomes equal to 10. That is, the maximum saving of fuel possible by use of a gas-producer plant instead of a non-condensing steam plant when the weight of fuel required during the heating season for heating alone is equal to or greater than that required

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for power alone, is 10% of that required by the steam plant.

While the experiments at St. Louis indicate that for power alone the gas-producer plant is much more economical in the use of fuel than a non-condensing steam engine plant, this analysis shows very clearly that when the fuel required for heating is taken into account the economy in total fuel used by a gas-producer plant and the necessary heating plant together, may not be so great as compared with the weight of fuel used by a steam plant as to warrant the use of a gas-producer plant.

It is probable that a gas-producer plant with its attending heating plant would not be as economical even in fuel in an office building or a large mercantile building as a non-condensing steam plant. Further, the charges for depreciation and repairs; for labor of operation, and for greater space occupied would surely be greater for the gas-producer plant than for the non-condensing steam plant. In electric generating plants, some factories, and other establishments where the question of heating enters very little, if at all, and the generation of power is the chief object, the gas-producer plant will show a very marked economy as compared with the non-condensing steam plant. What is needed in order to enable the gas-producer plant to compete successfully with the non-condensing steam plant in establishments where heating is an important item is some method of utilizing for heating purposes a part at least of the heat rejected by the gas engine.

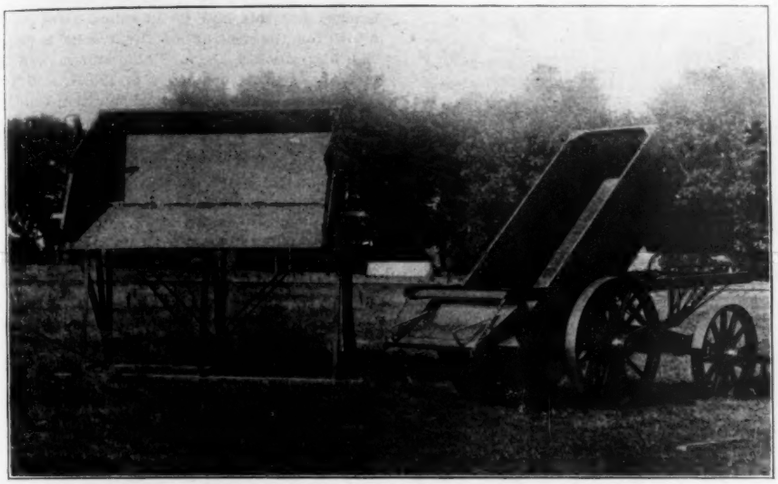

FIG. 1. CONTRACTOR'S DUMP WAGON AND LOADING HOPPER.

GAS PRODUCER PLANT VS. CONDENSING STEAM PLANT.

The preliminary report of the tests made at St. Louis says nothing of a comparison made between a condensing steam plant and a gas-producer plant, but judging from the results of the tests quoted in connection with the non-condensing steam plant it is probably safe to say that a good gas-producer plant would not use more than 70% as much fuel for power purposes as a good, high grade condensing steam plant.

In the case of a condensing steam plant run condensing during the heating season as well as during the warm weather, steam for heating would have to be taken directly from the boilers; and the weight of fuel used during the heating season would be $x+y$. Since the weight of fuel used during the non-heating season would be x, the total weight of fuel used during a year would be $2x+y$. The weight of fuel used during the year by the gas-producer plant would be as before, $2nx+y$. The saving of fuel effected by the gas-producer plant would be

$$2x+y-2nx-y=2x-2nx$$

and the per cent. c, of saving would be

$$c=\frac{2x\,(1-n)\,100}{2x+y}.$$

If we make n equal 0.7 which is the same as saying that the gas-producer plant will use for power alone only 70% of the fuel used by the condensing plant for power alone, the expression for c becomes

$$c=\frac{60x}{2x+y}.$$

If there is no heating y is zero, and c is 30, which means that when there is no heating the gas-producer plant would effect a saving of 30% of the fuel that would be used by the condensing steam engine plant required to do the work.

If, however, there is heating and the fuel required for heating alone is equal to that required by the steam plant for power alone, y is equal to x; and the saving that would be effected by the use of a gas-producer plant is 20%. And if the fuel required for heating alone is twice that required for power alone by the steam plant, y is equal to 2x; and the saving effected by the gas-producer plant is 15% of the fuel that would be used by a condensing steam plant.

If later tests should show that a gas-producer plant will use for power purposes more or less than 70% of the fuel that would be used by a good, high grade condensing steam engine plant to develop the same power, the method followed in the analysis given here will not be affected, although the results of the analysis as applied to condensing steam engine plants will have to be modified somewhat.

CONTRACTOR'S LOADING HOPPER, CONCRETE SPREADER AND DUMP WAGON.

In unloading freight cars into wagons there is always lost team-time, even where extra wagons are provided. Moreover, unless extra wagons are available, the workmen engaged in unloading the cars are apt to be idle at intervals while waiting for a wagon. This idle time is seldom regained by working at a higher rate of speed when the wagon finally arrives. To reduce both the lost team-time and the lost time of laborers, a loading hopper has been invented by Mr. J. E. Briggs, of Waterloo, Ia. This loading hopper, as shown at the left of Fig. 1, consists of a steel box mounted on a steel frame provided with oak sills. The hopper is placed at the side of the car to be unloaded, and it is filled while the wagon is on the road. The empty wagon is driven alongside the hopper, when, upon releasing a latch, the apron opens and the hopper tilts, thus filling the wagon at once. The loading hopper can be shifted from one end of the car to the other, as it is comparatively light, weighing only ½ ton for the 1½-yd. size. Two larger sizes are made, namely 2-yd. and 2½-yd., for use with large wagon boxes.

The dump wagon, shown at the right in Fig. 1, is also an invention of Mr. Briggs. The wagon box is of No. 10 steel, and when used for hauling hot asphalt it is covered with asbestos board and an outer covering of No. 18 steel. By adjusting the chains attached to the rear of the wagon, the body can be made to dump its load in a heap or to spread it in any desired thickness. The body is made wider at the rear than at the front to facilitate the discharge of the load. The wheel base is short, 4½ ft., so that the team and wagon can turn in a 12-ft. circle. The wagons are made in three sizes, 1½, 2 and 2½ cu. yds. capacity, and weigh from 1,800 to 2,500 lbs. It is stated that bricks can be dumped from these wagons with no loss by breakage.

The concrete spreader, Fig. 2, is another device introduced by Mr. Briggs. It is a steel hopper hung between two wheels. Its capacity is 2-3 cu. yd., and its weight 600 lbs. The concrete is dumped through a bottom gate, operated by a lever. This gate can be adjusted to spread the load to any desired thickness and within 2 ins. of the wheels. Concrete for paving is now being made by mechanical mixers in large quantities, especially where Portland cement is used, for with a slow setting cement it is possible to haul the concrete a mile from the mixer to the work. The ordinary wagon, however, dumps the concrete in a large pile, necessitating a considerable amount of labor in spreading the concrete with hoes and shovels. This new concrete spreading cart delivers the concrete in a layer, so that very little subsequent spreading by hand is required.

The steel boxes for these three machines are made for Mr. Briggs by the Tallerday Steel Pipe & Tank Co., and the wheels and running gear by the Ferguson Mfg. Co., all of Waterloo. The Barber Asphalt Co. is using 15 of the wagons, three of the hoppers and two of the spreaders in its street paving work at Waterloo, and is said to have effected a material saving in the cost of hauling and spreading the concrete by this means.

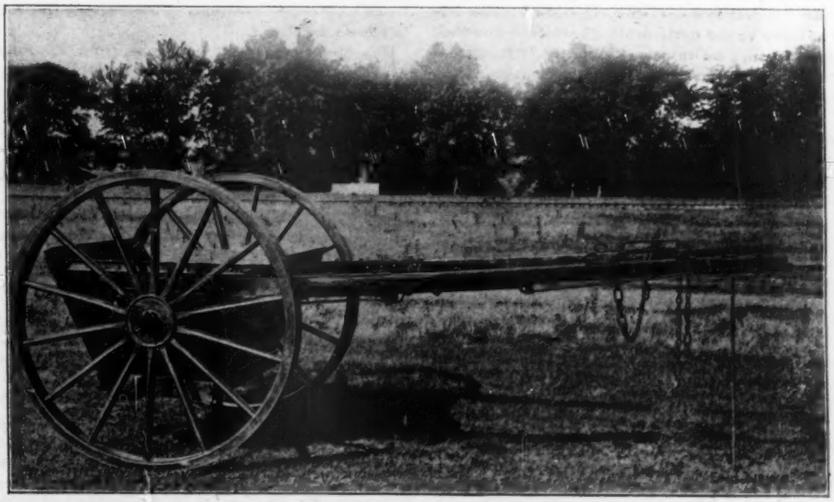

FIG. 2. CONCRETE SPREADER.

TRACK ELEVATION ON THE CHICAGO & NORTHWESTERN RY., CHICAGO.

In the comprehensive scheme of the elevation of railway tracks throughout the city of Chicago, the Chicago & Northwestern Ry. has played an important part, both in the extent of the work and in the rapid and economical execution of this difficult work. In our issues of Jan. 11 and Feb. 22, 1900, we described the general scheme and also the work of the several individual railways. The Chicago & Northwestern Ry. has already elevated several miles of its lines, and is now elevating a part of its Galena Division in a very busy section of the city. Last year it elevated nearly two miles of double track main line and a large freight yard north of the Chicago shops, consisting of 44 miles of track. It is now planning the elevation of the line from Western Ave. to Canal St., including the yards at Wood and 16th Sts., and 27 miles of yard and main track. The foundations for this work will be built this year. A continuation of the elevation on the Milwaukee Division from Belmoral Ave. (the present end) to the city limits will be the next work, and it is expected that the line will have to be elevated through Evanston.

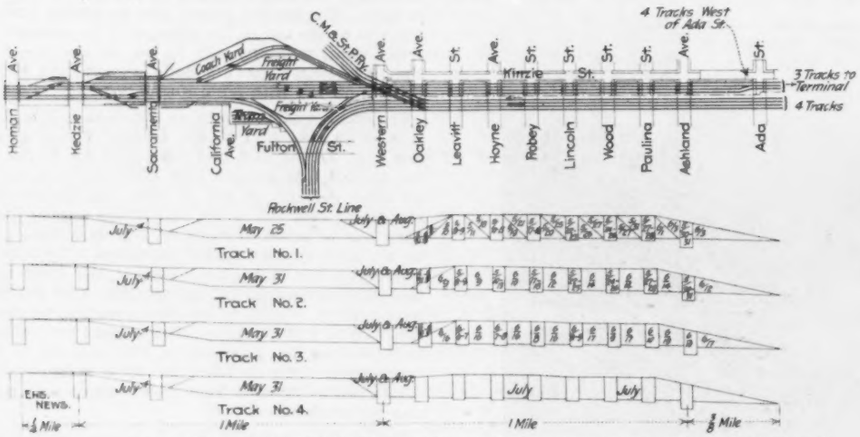

FIG. 1. PLAN AND PROGRESS PROFILE OF KINZIE ST. TRACK ELEVATION; CHICAGO. Chicago & Northwestern Ry.

The stretch of track elevation now in progress is an important and difficult piece of work, extending from Ada St. west to Kedzie Ave., 2.4 miles, including a large freight yard, and involving work also on lines of other railways. The general location and character of the work are shown by the map and progress profile in Fig. 1, but it will be of interest to explain the situation. The Wells St. terminal station of the Chicago & Northwestern Ry. is on the east bank of the Chicago River, and the river is crossed by a double track drawbridge, the line here being on the level of the streets. On the west bank, the Milwaukee Division turns to the north while the Galena Division extends due west along Kinzie St. It passes through a busy section of the city, but the elevation of the terminal and its approaches has not yet been required by the city. The present track elevation, as shown by the map, begins at Ada St., 15 blocks (one mile) from the river and from here to Western Ave. the railway has a 54-ft. right of way with four tracks, while parallel with and adjacent to this is the right of way of the Pittsburg, Cincinnati, Chicago & St. Louis Ry., which also has to elevate its tracks. The tracks of this latter road are used by the Chicago, Milwaukee & St. Paul Ry., which has a grade crossing with the Chicago & Northwestern Ry. at Western Ave. Beyond this crossing are the extensive freight yards of the Chicago & Northwestern Ry., and these have had to be elevated, as well as the connection with the Rockwell St. line, which was elevated a few years ago. (Eng. News, Oct. 28, 1897.)

The distance from Ada St. to Kedzie Ave. is 2.4 miles, and the work involves 11 miles of main track and 12.7 miles of yard track, besides 50 miles of main and yard tracks of the other two railways mentioned. The traffic over this stretch of line is extremely heavy, including through and suburban trains, light engines, empty trains, some freight traffic and frequent switching movements. A coach yard near the river has had to be abandoned, and all empty passenger trains have now to be run to and from the station over the part of the line to be elevated, thus increasing the traffic. There was also continual shifting of the tracks, and shifting of traffic from one track to another, to allow the work to progress, and these changes involved much work in the changing of switches, signal connections, etc.

RETAINING WALLS.—On the north side of the work is a masonry retaining wall, and masonry abutment walls have to be built on the lines of all the cross streets. On the south side the bank will adjoin that of the Pennsylvania Lines. The work was commenced last autumn (after the close of the heavy summer traffic) by putting in the foundations for retaining walls and street abutments, and building the masonry retaining wall along the north side of the right of way. Piles were driven along the line of the face of the wall, a follower being used to get their tops down to the elevation of the bottom of the concrete footing. Where the line of the wall was so near to the 4-ft. brick sewer in Kinzie St. that the driving of timber piles along this line would crack the sewer, concrete piles were made by making deep holes and filling these with concrete. The trench for this wall foundation was then excavated with a steam shovel, and the concrete was at once put in. When this had become thoroughly set, rails were laid upon it (at about the level of the streets and tracks) for derrick cars by which the stone blocks for the wall were taken from cars on the next track and set in position. This part of the work is shown in Fig. 2.

The stone is a gray limestone from Wisconsin quarries owned by the company. It is quarried out of ledges 14 to 22 ins. thick. The stones of the face courses are very large, and those of each course are of practically uniform thickness. The only dressing is on the face stones, which are pitched off to a straight line around the edges, and the stones for any one course are not dressed to exact thickness, any slight differences being made up in the cement mortar joints. There is a coping of red Wisconsin sandstone and on some parts of the work there is also a projecting course or sub-coping of the limestone. A mason gang with derrick car could lay from 75 to 100 cu. yds. of wall per day, and it is estimated that under the circumstances the cost was at least as low as that for a concrete wall. The shape and dimensions of the wall were shown in our issue of Feb. 23, 1905. To put in the foundation for the abutment walls (transverse to the tracks) a single span of falsework consisting of wooden stringers on mud sills was put in for each abutment without interrupting traffic, and an excavation made under the track. With the track thus carried by falsework, the space between the mud sills was excavated and the concrete foundation put in. After this had set, the falsework was removed, earth was filled in, and the work left for the winter. Three tracks were in use at this time, the north one being used for a work track, and the two south tracks for traffic.

OVERHEAD BRIDGES.—Before the policy of track elevation was adopted by the city, the authorities had in several cases required railways to eliminate individual grade crossings by building viaducts over the tracks. On this piece of work there were two of these highway viaducts which had to be removed; and there was also a bridge carrying the Metropolitan Elevated Ry. over the tracks, and this had to be raised some 10 ft. to allow for the raising of the tracks beneath it. The highway bridges, at Ashland Ave. and Western Ave. (with truss spans of 190 ft. and 140 ft., respectively), were removed by the Chicago & Northwestern Ry., falsework being erected to support the lower chords. The railway also removed the north incline approach in Ashland Ave., restoring the street to the original grade. The north approach on Western Ave. was removed by the Chicago, Milwaukee & St. Paul Ry., and both the approaches on the south were removed by the Pennsylvania Lines. For the north approach of the Ashland Ave. bridge, a steam shovel was put in and narrow gage tracks laid to an incline on the outer side of the retaining wall for the track elevation. The dump cars were hauled up this incline by a cable and hoisting engine, and dumped into railway cars standing on a track below, on the inner side of the wall, as shown in Fig. 3. This plan was adopted in order to have the work done rapidly and economically. The bridge of the Metropolitan elevated railway (250 ft. span) was raised gradually by jacking up the end bearings, and then building up the masonry of the abutments. The plate girder approaches had, of course, also to be raised for some distance so as to give a satisfactory grade. This work was done

Fig. 2. Derrick Car Building Stone Retaining Wall for Track Elevation.

by the elevated railway company's engineering staff, which has had several similar pieces of work to perform (Engineering News, Sept. 30, 1897).

SUBWAY BRIDGES.—The streets will be spanned by steel bridges, which are peculiar in having no longitudinal girders, and Figs. 4 and 5 show the bridge over Ashland Ave., which is typical of the others. A floor of rectangular longitudinal troughs is used, and is supported by the abutments and by transverse plate girders on the intermediate columns. The columns are 13 ft. c. to c., and are of H section, composed of four Z-bars and a central web plate, with batten plates

riveted across the flanges. The transverse plate girders are 3 ft. 8 ins. deep and fit between the columns, resting on knee braces. The troughs are 15⅝ ins. wide c. to c. of the web plates; the depth is 12¼ ins. over the angles for the sidewalk spans of 11 ft. 3 ins., and 18¼ ins. for the roadway spans of 24 ft. 6 ins. They are filled and covered with asphalt concrete, which is sloped to form longitudinal gutters, and upon this is laid the ballast. Along the outer line of troughs is a facia girder to retain the ballast. The bridges for the adjacent tracks of the Pennsylvania Lines will also have trough floors, but independent of those of the Chicago & Northwestern Ry. The longitudinal opening along the property line will be covered by arched beams of reinforced concrete, as shown. The unit stresses of these bridges are as follows: live load, 9,000 lbs.; dead load, 18,000 lbs.; shear for rivets, 7,500 lbs. for shop and 6,000 lbs. for field rivets; bearing for rivets, 15,000 lbs. for shop and 12,000 for field rivets. The live load provides for two 177½ ton consolidation engines (100 tons on 15 ft. of driving wheelbase) followed by a uniform load of 5,000 lbs. per ft. of track. There is no allowance for impact, owing to the use of the solid ballasted floor.

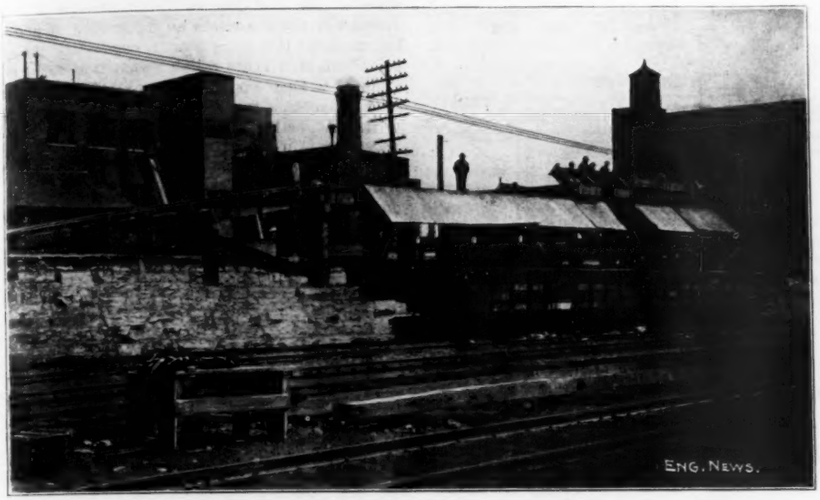

FIG. 3. HANDLING EXCAVATED MATERIAL FROM ASHLAND AVE. BRIDGE APPROACH.

STREET IMPROVEMENTS.—The two streets at the ends of the track elevation, Western Ave. and Ashland Ave., will be slightly depressed, but all others will be carried through at normal grade. Some water and gas mains will have to be lowered, and the streets must be paved by the railway company. In Kinzie St., which parallels the north side of the work, the company has built a new sewer and shifted the water main; in this work a steam shovel was used for the necessary trenching, on account of the rapidity of progress thus obtained. This street will be paved with brick and have a cement sidewalk, all at the railway company's expense. It is notable that the streets have only been blocked for the short time necessary to drive piles for the temporary trestles to carry the elevated tracks over the streets. An exception to this is where the Pennsylvania Lines blocked one or two streets at the south side. On some other pieces of track elevation work in Chicago, there has been wide complaint on account of the blocking of the streets for long periods of time, causing interference with traffic and also hampering the work of the fire department.

Near the end of the work is the old Sacramento Ave. subway. This was built before any tracks were elevated and was described in our issue of Sept. 21, 1893. It was altered in 1895, when the tracks were elevated between Sacramento Ave. and North 40th Ave., as noted in our issue of Aug. 20, 1896. It is very dark, damp and dirty, and being below the grade of the sewers, water collects in spite of an automatic air pump which raises the water to a sewer manhole. This subway is to be entirely rebuilt, and with a less depression of the street, owing to the increase in the elevation of the tracks crossing it.

TRACK ELEVATION.—The work of raising the tracks was commenced early in the spring of 1905, being started on the north tracks in the Western Ave. yard. When the work on the retaining walls east of Western Ave. had advanced sufficiently to permit of it (about May 20) the elevation of the main tracks was begun on the north track, east of Oakley Ave. While a track pile driver was driving the piles for the two north tracks (Nos. 1 and 2) on Leavitt St., sand trains were run upon track No. 2 on the west side of the street, unloaded, and the track raised on this material and thrown over to the position of track No. 1. As soon as the pile driver had left the first street, track No. 2 was cut east of the bridge, and lined over into the position of track No. 1 as it was being raised. Both approaches to the bridge were then rapidly filled, the piles cut off and capped, stringers and ties put in place, and the track carried across the bridge. Sand trains then used this track while hauling material for filling the space between the bridge just finished, and the next one at which the pile driver was working, while other trains backed in from the east, depositing material for beginning the east approach to the second bridge. These operations were continued, working east from street to street. At the ends of the retaining walls, framed bents supported on the masonry were used instead of piles. Grades as high as 5% were used in making the elevation, the trains returning to the original level at the streets, but when passenger trains were run over a part of the work grades of 2% were used.

When this one track was finished, the piles for the third track were driven, the second track was abandoned, and rail joints disconnected and the track tilted up sideways, supported by struts or braces. Sand trains on the first elevated track then widened the bank from the side, and when a sufficient width was obtained a derrick car on track No. 1 hauled up the 30-ft. sections of track No. 2 and set them in position, where they were quickly connected up and the track lined and surfaced. The derrick car also set the caps, stringers and rails on the trestle. The second track being completed, it was then used as a work track for filling in for the third track, while the first track was turned over to the transportation department during the busy hours of the day. Owing to the proximity of the main tracks of the Pennsylvania Lines, and the delay of that company in its track elevation work, it was not possible to raise the fourth track in the way described, as the slope of the bank would have encroached on the adjacent tracks. This track was therefore shifted about 2 ft. out from its original position and blocked up at an angle of about 45° to act as a revetment to the bank, being anchored by inclined ties about 4 ft. apart, embedded in the bank, as shown in the section, Fig. 6.

When this work was completed, the foundations for the abutment walls (built some months previously, as already explained) were uncovered, and the masonry walls built upon these for the full width of right of way, between the piles of the temporary trestles. The walls being ready, track No. 4 will be taken first, and the floor system (delivered on cars on track No. 3) will be set in place by derrick cars. The track will then be turned over for traffic. Track No. 3 will be cut at each bridge and connected across the bridges on track No. 4, when the temporary bridges on track No. 3 can be abandoned, and the steel structures put in place; after this the temporary structures on the line of tracks 2 and 1 will be similarly replaced, the tracks swinging to the south to cross each street while the new bridges are being built. As soon as the north bridges are built, the tracks will all be straightened. The tracks will be swung to the south on

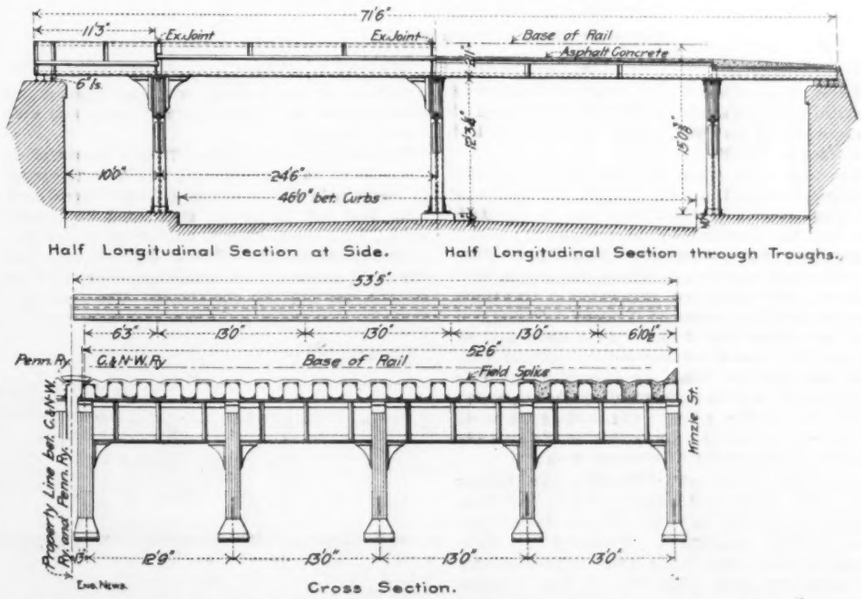

FIG. 4. SUBWAY BRIDGES FOR TRACK ELEVATION: CHICAGO & NORTHWESTERN RY.

only two streets at a time. No falsework or trestling will be built for track No. 4, for reasons above stated, but its bridges will be set on the walls. The work has been hampered and delayed somewhat by the slower progress made in the elevation of the tracks on the adjoining right of way of the Pennsylvania Lines.

During the progress of the work, two of the four tracks were left open for regular traffic except

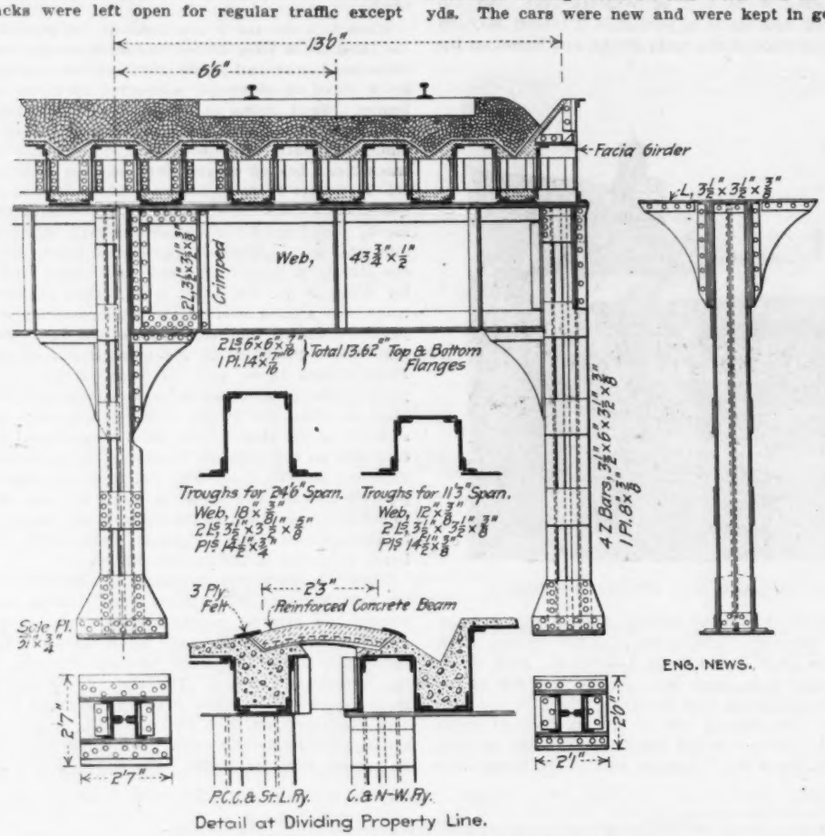

FIG. 5. DETAILS OF SUBWAY BRIDGES.

between 10 a. m. and 4 p. m., when all traffic was handled over one track, being under the control of an operator at each end, one at Western Ave. and the other at Ada St.

The four-track grade crossing of the Chicago & Northwestern Ry. and Chicago, Milwaukee & St. Paul Ry. at Western Ave. will be retained, but will be protected by an interlocking plant. The raising of this crossing will be a difficult piece of work, and in order to relieve the traffic temporarily, the latter line will make a two-track junction with the former at Western Ave. and run over its tracks Nos. 2 and 3 to a point east of Leavitt St., thence turning out to connect with the Pennsylvania Lines at Hoyne Ave. This arrangement will be understood by an inspection of the plan in Fig. 1, and will facilitate the work of putting in the new four-track grade crossing and interlocking plant at Western Ave.

FREIGHT YARD.—The Western Ave. freight yard, with about 11.8 miles of track, has been elevated about 6 ft. to 11 ft., and the tracks have been entirely rearranged. Formerly the main tracks formed a loop to the south to pass around the yard, but now there will be four straight main tracks (the two south ones for passenger traffic and the two north ones for freight traffic) with a yard on either side. These four tracks will be slightly above the level of the yards. This work includes a very complete drainage system for the yards, with connections to the city sewers.

The yard was abandoned temporarily by the transportation department, use being made of a large yard elevated last year near the Chicago shops. Sand trains were run in and dumped, and the material put under the tracks. Some of the tracks were raised 4 or 5 ft. horizontally or tilted up at an angle of 45° and supported by stakes and posts under the ties, while sand was shoveled under from trains on adjacent tracks.

WORK TRAINS.—The equipment used in this work consisted of gondola cars with fixed ends and side panels hinged to swing outward from the top. The cars are of 40 tons capacity and weigh 15 tons; their cubic capacity is 36 cu. yds., and their average load on this work was 33 cu. yds. The cars were new and were kept in good condition and well oiled by repair men at the gravel pits so that the trains ran easily and were readily handled.

The material was obtained from a gravel pit at Cary, 38 miles from Chicago, and here the track arrangements and methods of work were carefully laid out to ensure quick and economical work. Two steam shovels worked night and day, each averaging from 3,000 to 4,000 cu. yds. per day of 12 hours, with a maximum record of 4,500 cu. yds. per day for one shovel. The cars were made up into trains of 30 cars as a rule, a 40-car train being the maximum. These were hauled by ten-wheel engines on passenger schedules, usually following passenger trains from Cary to Chicago. This, with the care to keep the trains in proper condition, and the fact that they were under the control of the track elevation department, ensured prompt and rapid service. On reaching the track elevation, the trains were broken up into sections of 6, 8 or 12 cars (according to the length of track to be filled); they were then backed up over the work and unloaded, after which the empty cars were made up in trains to go back to the pit. From 6,000 to 12,000 cu. yds. per day have been deposited.

All unloading was done by hand, and the average cost of unloading was about 5 cts. per cu. yd. Plowing might have been a little cheaper and quicker in the yards, but not on the main tracks, owing to the amount of switching required, especially as the trains were broken up into sections for filling the short stretches between cross streets. In addition to this, there is a large amount of work required on the ground, in shoveling material into place, etc., necessitating the employment of a large force, which it is most economical to keep busy all the time. The same gang that unloaded a train, also leveled or trimmed the bank, laid the ties, tamped the track and did other necessary work, and was thus kept busy all the time. A train of 30 cars can be unloaded by shoveling in half an hour, and it is claimed that no quicker time could be made by the use of an unloader. This is especially the case here, where the sand trains are broken up into sections, owing to the short distance between streets and the consequent short stretches of work. From 1,000 to 1,200 men have been employed, and 16 engines were used in this service, including those at the pit, on the road, and on the elevation work.

With the exception of a small proportion of dirt from the stripping of a new gravel pit, all the filling is of clean sand and gravel. This material has the advantage of giving a solid and substantial bank at once, with very little settlement, while it also serves to ballast the track at once. With the clay and miscellaneous dirt as used in some similar work the settlement continues for a long time, necessitating frequent attention, while gravel must be hauled in as ballast before traffic can be carried.

SIGNALS AND INTERLOCKING PLANTS.—In connection with the track elevation work, a new all-electric interlocking plant has been built at Kedzie Ave., where the transfer freight tracks from 16th St. cross the main line of the Galena Division; and the interlocking plant at Ada St., where the three-track system from the east changes to four tracks, has been enlarged and changed to an all-electric plant. The Chicago, Milwaukee & St Paul Ry. will install a similar plant at the Western Ave. crossing. The block signal system in this district was changed from electro-pneumatic to Hall disk signals, and they were kept in operation throughout the work of elevation. Mr. J. A. Peabody, Signal Engineer, had charge of the installation and rebuilding of all interlocking plants, and signals.

ORGANIZATION.—The track elevation work is under the general direction of Mr. E. C. Carter, M. Am. Soc. C. E., Chief Engineer of the Chicago & Northwestern Ry. There is an Engineer of Track Elevation, who is in charge of all work of this kind, and who on this piece of work has two assistant engineers; one of these is in charge of subways, piling, masonry, street improvements, etc.; the other is in charge of the raising of the tracks. Each of these assistants has a general foreman. There is a trainmaster at the Western Ave. yard to attend to the distributing of loaded cars and the making up of empty cars into trains. There is another trainmaster at the gravel pit at Cary, and the latter also has charge of sending out

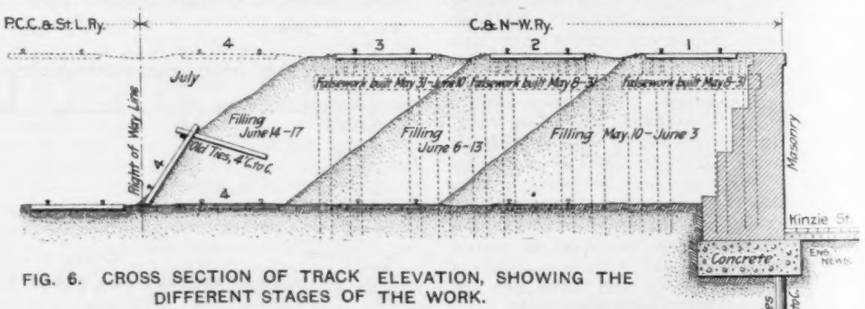

FIG. 6. CROSS SECTION OF TRACK ELEVATION, SHOWING THE DIFFERENT STAGES OF THE WORK.

the trains for Chicago. All branches of the work, including the handling of the gravel trains, are in the hands of the track elevation department, thus greatly facilitating the management of the work, and consequently the rapidity and economy of its execution.

EARTH DAMS WITH CONCRETE CORE WALLS.

By Clemens Herschel,* M. Am. Soc. C. E.

The fact that the above-named form of construction is the result of consecutive improvements in the building of earth dams, made in the course of at least 30 years' work, and the outcome of millions upon millions of dollars of construction cost, does not appear to be generally known. As at present built, earth dams with concrete core-walls are the successors of the archaic clay puddle core earth dams, as originally built in Europe, and of the thin masonry core wall earth dams which followed that form of construction.

Clay puddle was used in the belief that it would furnish a water tight barrier, should other parts of the earth dam be pervious here and there. But, in drying out, clay puddle becomes cut up with cracks and seams, making it unreliable as a final water-stop when the earth dam proper, at any point, through accidental or unavoidable defects in its construction, fails to be impervious. For this reason it has in American, also in German practice, perhaps also in the practice of other countries, been abandoned; certainly for high earth dams. In the writer's judgment, the use of clay in the construction of all dams, including cofferdams, is to be deprecated and avoided whenever any other material is at hand, as there generally is; but it would be somewhat foreign to the present subject to expatiate on this branch of it.

The Chestnut Hill reservoir dams in Boston, built about 1860-65, have puddle core walls, and are perhaps the latest examples of that form of construction, at least of any great size, in the United States.

Masonry core walls are more inconvenient, hence more costly of construction, than concrete core walls, more so now than ever before; for which reasons concrete core walls have replaced them. And for many years the concrete core wall earth dam has become the standard form of construction, readily built and giving excellent results in operation.

To illustrate: Under the direction of the present writer, was built the Canistear dam in New Jersey, nearly 700 ft. long and holding water 50 ft. deep, between June 10 and Nov. 1, 1896, filled by August, 1897, and in use without material repairs from completion to date. Probably no other tried or suggested form of construction could equal this example in celerity of construction, nor in subsequent reliability of operation.

As giving the writer's views and methods on the present subject, he will quote from Part 2, 1897-98, Proceedings of the Institution of Civil Engineers, from his discussion of the paper on "Reservoirs with High Earthen Dams in Western India:"

> His view of the essentials of an earthwork dam was a structure, composed of an unstable water tight curtain fastened across the water tight surface of a valley, extending up to a horizontal line and held up or supported on each side by an earth fill. The slopes of the earth fill must be protected, on the one side against wave action, on both sides and on top against the destructive effects of rain. There must be a wasteway able to discharge the greatest known, or to be expected, flood, without raising the water higher than flood level in the reservoir, and there must be a way provided to draw off the water as wanted. Before discussing how this program was to be embodied in earth, stone and metal, he would define some of the terms he would use. Clay was sticky, treacherous and mud-producing. It encumbered the site of the works, and he had never found a use for it, except to make clay-rolls for pouring lead-joints, in an experience on hydraulic works, during the past 35 years. When present on the ground it must be endured, but he had never allowed it to be brought to the site of the works. Gravel was a natural mixture of earth, sand and pebbles; of various attributes and consistencies; some of which was good for building earth dams, and some not. The best for that purpose was gravel that would puddle, or "binding gravel." To tell whether any given gravel would puddle, and to judge of its fitness for use in a dam, it should be mixed with water in a pail, to the consistency of moist earth about to be used in a dam, or before rolling. If, on turning the pail upside down, the gravel remained in the pail, it was fit for use; but if it dropped out, it should be discarded. Good gravel, or binding gravel, would make the best of cofferdams, or filling for sand bags to be used in cofferdam work, and earth dams. It would remain water tight, where clay would melt out and disappear like soap or sugar. Good earth or gravel, stone and metal parts being provided, the method he advocated for the construction of an earth dam was the following: The site should be cleared of perishable material, and a trench dug down to waterproof strata. If good rock was found within 25 ft., or 30 ft., or 35 ft., a start should be made upon it, but if not, excavation should proceed with some sort of stop-water until there was no danger of water passing out from the reservoir down the valley, in quantity, underneath the bottom of the trench. This was a matter of judgment. A concrete or masonry core wall should be constructed in this trench, say 4 ft. or 5 ft. thick at the bottom, 8 ft. thick at the original ground level, 4 ft. thick at the top. These were dimensions for first-class work; but such core walls had been built, only 2 ft. thick uniformly from top to bottom. At the same time with it should be built up the earth dam on each side of it, using for the earth dam good binding gravel, hauled on and spread in 4-in. or 6-in. horizontal layers. These should be sprinkled with a hose constantly, and rolled with grooved rollers plentifully, and until a hole dug in the gravel would hold water like a pail. The grooved rollers were made of disks of cast iron strung on an axis, the alternate disks being of the same diameter; and contiguous disks, about 2 ins. smaller and larger in diameter than their neighbors. Such rollers could be turned easily, and their total weight was concentrated on an aggregate bearing surface equal to only half the length of the whole roller, and therefore more effective where it rolled than if the whole length touched the earth. Slopes of 2 on 1 were sufficient for both sides of the dam; 1½ as well as 2¼ have been used. Berms were advantageous during construction, as level trackways, from one side of the valley to the other; but their use was a matter of fancy, largely. He favored them and had always used them for earth dams over 40 ft. high. A gravel walk should be made on the top of the dam, and a vacant strip left on each side of it, to the edges of the dam. These top strips and the berms should be sown with grass. The back or down-stream slopes might be sown, or sodded, or covered with a layer about 2 ft. thick, of small (8 or 9 ins. in diameter) stone culled out of the gravel filling while building the dam. The waterside was paved. He had used with success large boulders from the borrow pits with smaller boulders and small stone in the interstices.
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> * * * * * * * * * *
>
> The wasteway was a separate structure. Nothing but a smooth stone weir, of length sufficient to pass the maximum flood without unduly raising the reservoir water-level, seemed a safe arrangement. This type of safety-valve would not get out of order. The earth dam was safe against the attacks of vermin; they could not penetrate the core wall. The core wall was a safe stop-water to rely upon, whether of masonry or concrete. It would not crack like clay puddle. If it should crack, by faults of construction, the crack would not enlarge, should water reach it. It would be more likely to silt up. Drains under the dam were uncalled for. A dam of this kind had never indulged in such slips and slides as were portrayed in the paper. Such slipping could only be caused by a lack of staunchness of the whole structure. Water must have penetrated the body of the dam, and have come dangerously near to carrying away the whole of it. A core wall dam could be built in less than one summer season, and the reservoir filled with water the following winter. The main earth dam of the Canistear Reservoir of the East Jersey Water Co., of New Jersey, U. S. A., was about 57 ft. high from the original surface of the ground to the top, and about 672 ft. long on top. The water area of the reservoir when full was 323 acres; contents, 2,407,000,000 U. S. gallons (231 cu. ins.). The wasteway was 275 ft. long, to provide for the floods, possibly, of 10.5 square miles of drainage area.
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> * * * * * * * * * *
>
> In this way, a dense forest, on the site of the dam on June 10, 1896, gave place to the practically completed dam by Nov. 1 following; that is, 5 months later; when the gates were closed, and the water was allowed to fill the reservoir. The reservoir had been full since August, 1897.
>
> * * * * * * * * * *
>
> To build the Canistear Reservoir in 5 months cost about £9,000 more than it would have cost to build it in two seasons.

The bill of quantities of work is as follows:

Main dam and reservoir, clearing	440	acres.
" " " grubbing	440	"
Excavation on dam site	11,000	cu. yds.
Gate-house cut, rock	1,200	" "
" " " earth	5,700	" "
Core wall excavation, rock	2,450	" "
" " " earth	2,100	" "
" " concrete	8,000	" "
Dam, earth, including paving	98,000	" "
Gate-house masonry, brick	100	" "
" " " stone	1,500	" "
" " " concrete	150	" "
" fittings, pipes, valves, stairway, &c.		
New road	11,562	ft.
Overflow dam, excavation, earth	2,700	cu. yds.
" " " rock	1,450	" "
Masonry	4,500	" "
Auxiliary Dam, No. 1.		
Clearing site of dam	850	cu. yds.
Excavation for core wall, rock	80	" "
" " " earth	150	" "
Core wall, concrete	300	" "
Earth dam, including paving	1,400	" "
Auxiliary Dam, No. 2.		
Clearing site of dam	950	" "
Excavation for core wall, rock	20	" "
" " " earth	600	" "
Core wall, concrete	750	" "
Earth dam, including paving	2,450	" "

Notwithstanding proof complete of the development by successive steps of perfection—the work of many able engineers—of this form of earth dam, and of its entire success in practice, one still meets with criticism of such construction like the following:

> The utility of the masonry core wall to this dam is not patent. It really converts the dam essentially from an earth and rock structure into an inefficient masonry one. By stopping all seepage of water, the rock and clay fill above the dam becomes thoroughly saturated, and the large proportion of soluble clay in its composition would make it, so far as pressure is concerned, a fluid heavier than water, with a correspondingly increased thrust. The down-stream fill would be completely drained, and could not be brought to an efficient bearing until it had been compressed by the pressure of the masonry dam against it, which would involve a yielding of the structure. The conditions, then, are highly favorable for a rupture of the core.

There is nothing in the context to the quoted sentences which would lead one to suppose that it referred to any particular material to be put into earth embankment. It reads as a criticism of that general form of earth dam construction and repeats, essentially, a criticism of such forms of construction, as it has occasionally been made by engineers from an argumentative standpoint, but unsupported by any personal experience of the writers, such as feared.

And this article is written, as there seems to be a professional need of someone to write, giving the history of and the justification for the form of construction considered.

No form of earth embankment will retain water when built of unfit material. But it is the writer's firm claim that concrete core wall earth dams will enable poorer material to be used for the earth embankment than could be so used with the concurrent use of any other method of earth dam construction.

The record of the entirely satisfactory behavior in operation of earth dams built as above criticized should be a sufficient answer to such attacks upon them. But it is also possible to reply to argument with other arguments, and to point out the mistaken premises upon which the quoted logical deductions are founded.

The rock and clay fill above the core wall does not become "thoroughly saturated" when properly constructed. If it did, the water could not be drawn off from the reservoir without causing this up-stream portion to slide into the reservoir; whereas, one of the necessary attributes of such dams is to allow the water level back of them greatly to vary, and the reservoirs in use have all had this water level thus vary 50 and 60 ft.; sometimes annually, sometimes at intervals of years, without harm and notwithstanding the heavy load of stone paving put on the up-stream surface slope of the dam, as a protection against wash from wave-action.

When properly constructed as above described, such earth embankments are impervious to water; not soluble in water. There would be no need of any core wall, if every man at work in the construction of the dam had the intelligence, will and ability to put into it nothing but perfect work. But such embankments are the outcome of the work of hundreds or thousands of the very lowest class of labor, and strive as the directing mind may, imperfections will creep in. If water once commenced to percolate an earth dam, the channel of percolation could readily enlarge, unless there were somewhere a reliable water-stop. And to furnish this is the office of the core wall. By preventing percolation the core wall prevents saturation in any material portion of the earth dam. In those portions unhappily or accidentally left open for percolation, it compels sedimentation and closure of the most minute water channels in a very short time. Thus canal banks well built,

*Hydraulic Engineer, 2 Wall St., New York City.

but with only wooden planks set up to form a water-stop, can be put into use as soon as finished, and they remain water tight after the planks have turned into mold.

Nor does "the large proportion of soluble clay in the composition of the earth dam" make it "so far as pressure is concerned, a fluid heavier than water with a correspondingly increased thrust." This has already been disproved from what has just been said. In point of fact, no such action takes place when an earth dam is properly constructed. Many earth dams have been built without any core wall or water-stop whatever, and owing to the skill and care used in their construction have held up high heads of water, without solvent action of the compacted material of which they were built, for 40 and for 50 years, or are yet standing.

The down-stream fill would, indeed, remain, not become "completely drained," but it would not need the pressure of the masonry dam against it, caused by a yielding of this structure, to bring it to an efficient bearing against the core wall; for the reason, that such efficient bearing is produced throughout every part of the down-stream, as well as up-stream face of the core wall, from the manner in which the earth fill is built up, with accompaniments of sprinkling and rolling and tamping of the thin horizontal earth layers as they are deposited.

No case of a ruptured core wall in a well-built core wall earth dam has ever been recorded.

All ordinary earth dams, no matter how built, are only fit for reservoir, not for overflow or weir dams. It is the office of a properly constructed wasteway or weir dam, the necessary adjunct of all reservoir dams, to prevent overflow of the earth embankment portion of the reservoir dam.

If, however, in any case, the dam is to be converted into a dike, doing without a wasteway made especially for that purpose, and the dam itself made subject to more or less occasional overflows of limited duration, that would only change the covering of its top and down-stream face, and very likely the degree of slope of the latter. It should not affect the construction of the remainder of the earth dam.

In the quotation from the Proceedings of the Institution of Civil Engineers above given the case was touched upon of an earth dam to be built on a site on which the rock foundation was so deep below the surface level that it could not be reached expediently in a dry, open trench. In the writer's practice, he has always placed the core wall on a rock bottom, but he can well understand that other forms of construction must occasionally be employed beneath the core wall foundation. Such would be wooden sheet-piling placed in a trench; these, or the modern steel sheet-piling, sunk with the aid of a water jet; a core wall sunk to rock in sections with the aid of the pneumatic method; a core wall built on a caisson to be filled with concrete, and sunk in a trench excavated to rock by underwater dredging; in general, a core wall founded on rock and built in sections, as a bridge pier or a "sky-scraper" foundation is built. But when the last word is said, a general description of such extraordinary modes of foundation construction cannot well be given here. Specific cases of this sort will always need specific means for their treatment.

NOTES FROM THE ENGINEERING COLLEGES.

UNIVERSITY OF WISCONSIN.—A five-year course in Chemical Engineering has been established, beginning this fall. The course is so arranged that if a student can afford to give only four years, he will receive the degree of Bachelor of Science; however, if he completes the fifth year he will receive the degree of Chemical Engineer. The course aims to give a thorough training both in engineering and in chemistry, so that the graduate may be prepared to engage in the manufacture of cement, brick, tile, pottery, beet sugar, paper, paint, etc. The field for gas engineers alone is a promising one, and there are many other lines of chemical engineering activity that will be open to graduates. A bulletin has been issued giving the subjects that will be taught.

THE COLLAPSE OF A DEPARTMENT STORE BUILDING AT ALBANY, N. Y.

As reported in a brief note in these columns some weeks ago, a disastrous building collapse occurred in Albany, N. Y., on the morning of Tuesday, Aug. 8, 1905. A building occupied by the J. G. Myers Co. with a department store was undergoing certain alterations in the sub-basement, involving the undermining of some walls and columns. About 9 a. m. of the day mentioned, when this work was in active progress, a portion of the building collapsed, killing 13 persons and injuring many others. Doubtless the list of dead and injured would have been much longer had the accident occurred later in the day, after the arrival of the usual crowd of morning shoppers.

The contractor for the alterations, J. C. Dyer, Jr., and his employees could give no explanation of the accident, and there was no competent representative of the owner in supervision of the work. The Mayor of the city, Mr. Charles H. Gaus, therefore appointed a commission of three building experts to investigate the accident and determine its cause. The commission comprised Mr. William A. Cattell, M. Am. Soc. C. E., of New York; Mr. William F. Hanrahan, of Schenectady; and Mr. Charles P. Boland, of Troy, N. Y. The coroner charged with investigating the cause of death of the victims also appointed a commission of three, Messrs. R. Wickham, J. Hamer, and M. L. Emery, to report on the causes that led to the collapse of the building. These commissions presented their respective reports during the past week, and the coronor has announced his findings. Drawing on the material made available by these investigations, we present in the following a summary of the main circumstances of the accident, as far as these may be of technical interest.

The building in question fronted, west, on North Pearl St., being Nos. 39 and 41, and extended back to James St. on the east. On the sides, north and south, it was bounded by other buildings. The approximate horizontal dimensions of the building are 55 ft. wide (N.-S.) and 200 ft. long (E-W). The middle portion of the building, which alone was concerned in the collapse, was three stories high above the ground.

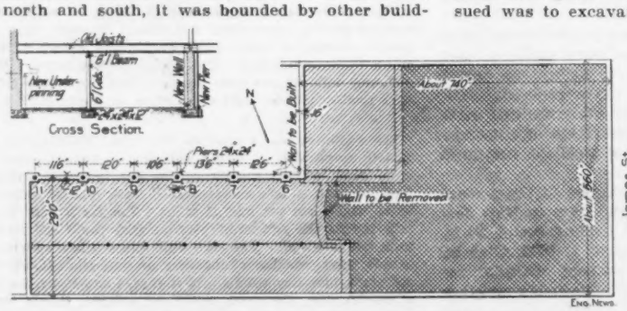


FIG. 1. PLAN AND SECTION OF SUB-BASEMENT AND EXTENSION, J. G. MYERS STORE, ALBANY, N. Y.

The ground surface at the site slopes down toward the east, so that James St. lies lower than Pearl by a height corresponding roughly to two stories. On the Pearl St. (west) end, the building extended one story below ground, giving a basement floor which ran the full length of the building, to James St. On the east or James St. end there was a sub-basement, lying about level with James St. and extending about 70 ft. inward. The work under contract at the time of the accident consisted of extending this sub-basement about 60 ft. west (toward Pearl St.), in the portion lying south of the longitudinal center line of the building; the corresponding space in the north half was to be left unexcavated.

The plan, Fig. 1, which shows the eastern portion of the building, something more than half the total length, will make this clear. The doubly-hatched area represents, to scale, the existing sub-basement. The singly-hatched area is the area whose excavation constituted the work in hand. This involved, besides the mere excavating, the following essential items of work: (1) underpinning the south wall of the building on a length of about 70 ft., carrying its foundation some 6 ft. lower; (2) removing the existing west boundary wall of the sub-basement; (3) underpinning the cast-iron columns which form the floor supports along the center line of the building, by constructing 24-in. square brick piers as footings under these columns from the old basement floor to the basement floor; (4) building about 130 lin. ft. of 12 and 16-in. wall to form the west and north boundary of the excavated area and to retain the earth beyond; (5) placing a line of longitudinal I-beams under the old basement floor joists in the excavated portion, and setting cast-iron columns at intervals under this floor beam, to reduce the span of these old joists.

Of this work, most of the actual excavating was done, items (1) and (2) and part of (5) had been completed, and item (3)—underpinning the columns in the middle line—was in progress. The work was conducted for the contractor by a superintendent named Daggett.

It is important to note, before entering into an account of the accident, that the work was undertaken by the contractor on a cost-plus-percentage basis, and not for a specified price. That is to say, the contractor had no inducement to save on expenses, and it is reasonable to infer that he was doing the work thoroughly and in the best possible manner, as defined by his and his subordinates' knowledge and ability. The extent and character of what he was to do under the contract was fixed by an architect's drawing showing a plan of the reconstructed sub-basement, two transverse sections, and some sketches of column details, on which drawing were noted the sizes of walls and piers, other necessary dimensions, and the various portions to be removed and to be constructed. Our Fig. 1 is a condensed copy of the principal parts of this drawing, omitting all unessential items.

At the time of the collapse the contractor's force was occupied mainly with underpinning the center line of columns and constructing the new foundation piers under them. The method pursued was to excavate to about finished grade at some distance from the columns, then erect on this base a frame of shores around each column, with capping timbers under the column caps at the first-story floor level, then jack up the shores, thereby taking the load off the lowest column section, and finally remove the old column footing, excavate under it, and build the new brick footing pier with concrete foundation block. Column 6 had, at the time of the collapse, been already set on its new foundation built after this procedure. Column 7 was resting on the false-work, the old footing had been removed, and the concrete base-block for the new pier had been placed; the shoring was, we are credibly informed, substantial and safe. Columns 8, 9, 10 and 11 still rested on their original footings, but the excavation in their neighborhood was well advanced, as shown in the part plan in Fig. 2. Column 8, in particular, was nearly ready for the shoring; indeed, the shoring was to be put in on the very day of the collapse. The excavation had been carried to full depth in the southern half, up to about 3½ ft. south of the center line; to the east, the edge of the full-depth excavation was about 4½ ft. from the column center; while on the north and west sides a trench or tunnel had been dug, five or six feet away from the column, to a depth of 3 ft. below the base of the old footing, or within 2 ft. of the finished sub-basement floor level. Near columns 9 and 10 there was less excavation; still, as Fig. 2 indicates, the edge of the full-depth excavation to the south was within 3½ ft. of these columns also. The sectional views in Fig. 2 show this more precisely.

The soil encountered in the sub-basement was an undisturbed clay, fairly clean and somewhat wet.

Shortly after the workmen reached the building on the morning of the collapse, it was noticed

that earth was crumbling from the southeast corner of the earth block under Column 8. A quantity amounting to a barrow-full or more spalled off, and following it came a piece of the old rubble-masonry footing. It is probable, though the evidence does not make it quite definite, that some earth had crumbled off the edges of this pillar during the night just preceding. At any rate a fair slice fell after work had been commenced on Tuesday, the day of the accident, and brought with it a piece of the column footing. By order of the contractor's superintendent, Daggett, the fallen earth was wheeled away, and the stone was sledged to pieces and also removed.

After the wreckage was cleared away it was seen that the fall was quite vertical. The footing of Column 8 was crushed. The basement section of this column lay close to the location of the column, pointing away from it in a southeasterly direction. The corresponding section of Column 9 lay similarly near its vertical, but pointing rather west of south. The bottom section of Column 10 was in somewhat similar position. The foundation masonry of Column 10, with a large mass of earth attached, was found, nearly completely overturned, south of its original location.

The structural characteristics of the building, while they are apparently not concerned in the accident, may be simply summarized. The floors were carried by wooden joists running transversely, which formerly rested in a wall on what is now the middle line of the building. As noted in the report of the Mayor's expert commission, this original wall was removed in 1881, and cast iron columns, carrying longitudinal girders for supporting the floor joists, were substituted. The longitudinal girders were of peculiar construction, sketched in Fig. 3. They were constituted by a horizontal strip of the old wall, reinforced by a two-piece cast-iron lintel on the bottom edge. The safe bending value of such a composite girder is problematical. Besides this line of columns there was, in some parts of the building, an intermediate line similar to the line shown in Fig. 1 on the middle line of the sub-basement extension.

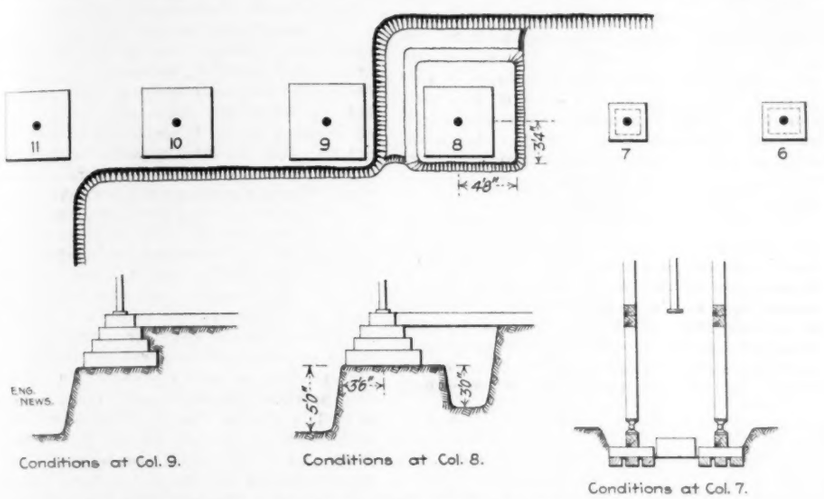


FIG. 2. PLAN AND SECTIONS SHOWING CONDITION OF WORK AROUND COLUMNS 7 TO 10, J. G. MYERS STORE, ALBANY, N. Y.

There is some evidence, however, in the testimony given at the Coroner's inquiry, that the earth along the outer edge under Column 8 continued to crumble, though slowly.

While this was going on, a clerk on one of the upper floors complained to an official of the store that much dust was falling from the ceiling plaster on her goods. The official then sent for Daggett, to ask him to use more care in his work. Daggett was busy ordering the work of getting out the shoring for Column 8, which was to be put in that day, and did not start to go upstairs until a moment or two before the collapse. About the same time the clerks on the basement floor immediately over Column 8 noticed that the floor seemed to sag a trifle; the department head, therefore, ordered them to come away from that part of the floor. Carpenters who were cutting a hole in the basement flooring around Column 8, to permit the passage of the shores, also left their work. A short time afterward, not more than five or ten minutes, the central part of the building collapsed. A section about fifty feet square, reaching from side-wall to side-wall, and east and west about twenty or thirty feet either way from

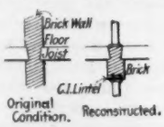


Fig. 3. Composite Brick and Cast Iron Lintel, under Floor Joists, J. G. Myers' Store, Albany, N. Y.

Column 8, fell in a heap into the sub-basement.

As already noted, thirteen persons were killed in the collapse. All were employees of the store, as were also most of the injured. Only one or two of the contractor's men were injured. The testimony before the Coroner showed that some of the men working in the sub-basement saw indications of the collapse in time to call away the others and reach James St. in safety. The superintendent had just started away from Column 8 to go upstairs in answer to the summons from the store officials when the collapse came.

The Mayor's expert commission reports on its investigation of the accident as follows:

We have carefully examined the ruins of the building, noting particularly the condition and location of walls, columns, beams and girders, during the progress of the removal of the wreck, the character of the soil under the foundations and the general character of the construction of the buildings themselves. We have also listened to the statements of the contractor, Mr. John C. Dyer, Jr., and his superintendent, Mr. Charles L. Daggett, as to the methods employed in doing their work and the progress and condition of the work at the time of the collapse.

The buildings occupied by the John G. Myers Company were originally private dwellings. They were altered and enlarged from time to time and it appears that the principal alterations, previous to those in progress on Aug. 8, 1905, were made in 1881. These alterations of 1881 (which we understand consisted principally in cutting out the center walls and substituting cast-iron columns and lintels therefor) together with the defects in the original construction of the dwellings, made the undermining and underpinning of this structure an exceedingly difficult and dangerous operation. Many of these defects were concealed by subsequent construction, but it does not appear that any thorough examination of the old buildings was made before the work was started, to ascertain if any structural weakness existed.

The work in progress on August 8, 1905, was that of excavating under the walls and columns supporting the base and upper stories of the building, and of underpinning these walls and columns for the purpose of constructing a sub-cellar. The work was started from the James St. end of the building and at the time of the collapse the excavation on the northerly side of the building had been completed as far as it was intended to carry it, viz.: to Column No. 6 (numbering from the James St. end). The excavation under the southerly half of the building had been carried to a point about half way between Columns 10 and 11. This portion of the excavation was completed approximately to grade which was about 5 ft. below the bottom of the old column foundations, and to a line averaging about 3 ft. 9 ins. south of the centers of the columns. The excavation around Column 7 had been carried down to grade to a line about 8½ ft. north of the center of the column, in a westerly direction to a point about 5 ft. from the center of Column 8. Column 7 was supported on shores and needles of ample size and strength to carry their load and the concrete base for the pier to support this column had already been placed. The excavation around Column 8 had been completed approximately to grade on the south, and to a level about 3 ft. below the bottom of the column foundation on the north and west, leaving a pier of clay approximately 10 ft. square at the base and 8 ft. square at the bottom of the column foundation, unconfined on the south and east and only partially so on the north and west. The column, however, was not located over the center of this clay base, but was approximately 3 ft. 4 ins. from its south edge and 4 ft. 8 ins. from its east edge. There was no shoring in place at Columns 8, 9 or 10 at the time of the collapse, the special work in progress on the morning of Aug. 8 being that of putting in the needle beams around Column 8 preparatory to placing the shoring. There is no evidence that any means were adopted to confine the column of clay supporting Column 8, nor the bank of clay on the edge of which Columns 9 and 10 rested.

From the foregoing it will be seen that on the night of Aug. 7, Columns 8, 9 and 10, each of which carried a very considerable load, were left standing on the edge of an unconfined bank or pier of clay, and it is our judgment that the collapse of the building was caused by the settlement of the clay under one or more of these columns, due to the pressing out laterally of the unconfined material supporting the foundations of the old columns.

It is our further judgment that the conditions existing at this building and the character of the work in progress demanded that extraordinary precautions be taken to insure safety. Had such precautions been taken the disaster could have been averted.

Substantially the same conclusions are expressed in the report of the Coroner's commission and in the official findings of the Coroner. The report of the former, after describing the nature of its investigations, says:

It is our opinion, individually and collectively, that the collapse of the John G. Myers building was due to the extension of the excavation for the new sub-basement, at full depth, too close to the center line of basement columns.

The Coroner's verdict uses almost the same language in describing the cause of the accident, and then makes the recommendation that, to guard against similar accidents in the future, the city of Albany establish a building department, with competent superintendent and inspectors

to pass on plans and specifications submitted for approval, and to see that any work proposed is carried out in a safe and workmanlike manner as required by the approved plans and specifications and such laws and regulations as may exist governing building operations in the city of Albany.

Simultaneous with his verdict, the Coroner caused to be issued a warrant for the arrest of the contractor, Dyer and his superintendent, Daggett, charging them with manslaughter in the second degree by culpable negligence in conducting the work.

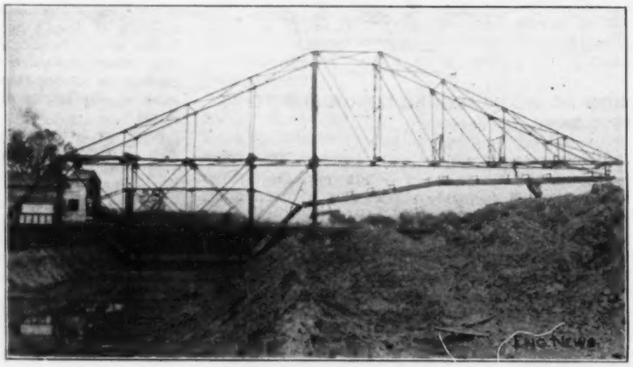
The control of building work in Albany is vested in the Chief of the Fire Department, who acts in the matter through a special clerk. The city has nearly 100,000 inhabitants. In this period, since the above-described accident, there has arisen a strong public sentiment for the establishment of a special Building Department.

A CROSS-CUT EXCAVATING MACHINE FOR DRAINAGE DITCHES.

In the construction of canals and drainage ditches it is important that the sides should be left smooth and even and trimmed to the proper slope, but with nearly all excavating and dredging machines the sides are either left rough and steep or are given a subsequent trimming, which latter process of course adds to the expense. In some large Belgian excavators of the ladder type, used on canal work, the machine travels along one bank and the ladder is at right angles to the track, the buckets traveling up the slope of the cut. This style of working is very exceptional, but the accompanying cut represents a new style of machine designed specially for excavating drainage ditches and irrigating canals, in which the cut is made transversely to the line of the canal and is finished to the required cross section by buckets running on a steel guide frame or template.

The machine is mounted on wheels traveling on rails laid on each side of the excavation, and is self-propelling. The cut shows the machine fitted and a cantilever frame to enable the buckets to dump at some distance from the machine, the engine and boiler serving as the anchorage. This style of machine is for building levees and two are now in use on the Illinois River between Pearl and Hillview, in Green County, Ill. The borrow pit is 65 ft. wide and the levee is 85 ft. wide at the base and with a maximum height of 20 ft. Only one bucket is used.

For ordinary ditch work, the machinery is mounted on the frame or bridge carried by the wheels on each side, and beneath it is the steel guide frame or template shaped to the required form of cross section of the excavation in each particular case. From each end of this frame extends an inclined steel boom, from the ends of which the buckets are dumped. There are two buckets, with wheels traveling on the guide frame and booms, and these travel in opposite directions, dumping automatically at the ends of the booms. All the operations of the machine are effected by a double-drum hoisting engine, and being self-propelling it requires no anchors or spuds or hauling tackle. This style of machine was used on the Inlet Swamp drainage district in Lee County, Illinois, for about 12 miles of ditch. We are informed that with a ditch 16 ft. wide on the bottom, and 6 ft. deep, having side slopes of 1 to 1, the machine frequently cut 180 lin. ft. in less than ten hours, the machine being subject to ordinary delays. This is equivalent to between 800 and 900 cu. yds., and was accomplished with the consumption of not more than a ton of coal. This machine weighed 30 tons and had a vertical boiler and a 20 HP. engine with cylinders 7×10 ins., operating two buckets of 1¼ cu. yds. capacity. The only labor required comprised the engineman and fireman on the machine, and one man with team to attend to the laying of the track.



CROSS-CUT EXCAVATOR FOR DITCH AND CANAL WORK; WITH CANTILEVER DUMPING FRAME FOR BUILDING LEVEE.

The ditches on the Inlet Swamp work were 24 ft. to 33 ft. wide on top, 6 ft. to 10 ft. on the bottom, and 5 ft. to 12 ft. deep, with side slopes of 1 to 1 and 1½ to 1. The material was black gumbo, blue clay, gravel and sand. The distance from center of ditch to center of dump was 35 to 40 ft., the runways being 45 ft. long, with a height of 12 to 25 ft. above the ground at the outer end. The contractors were F. M. Johnson and the A. M. Shaw Construction Co., and some particulars of this work were given in a paper on "The Inlet Swamp Drainage District," read by Mr. A. M. Shaw before the Illinois Society of Engineers and Surveyors, and published in our issue of Jan. 26, 1905. One of these machines in Indiana has excavated 1,425 cu. yds. in 9¾ hours.

Among the advantages claimed for this new machine are a reduction in power and labor as compared with a dipper dredge of the same capacity, while the banks are left with the proper slope and in better condition to prevent slides and to give the full capacity of flow for the channel. This machine is the invention of Mr. Charles C. Jacobs, President of the Jacobs Steel Excavator Co., Amboy, Ill.

ENGLISH STREET RAILWAY CONSTRUCTION.*

By Joseph Owen.†

RAILS AND FISH-PLATES.—The standard specification and sections of tramway rails and fish-plates issued by the Engineering Standards Committee are admirably suited to meet the varying conditions of traffic in this country, and their adoption enables the manufacturer to keep in stock a quantity of each kind of rail, while saving the cost of providing a new set of rolls for each individual order. On the other hand, when an article is brought up to standard, there is a tendency to suppose that finality has been reached, thus checking initiative.

Rails 60 ft. in length are now nearly universally used, as it has been found that they are but little more awkward to handle than those of 45 ft. Turning can be reduced to a minimum by arranging that the heads of each pair of rails are on opposite sides when loading them on the push cars for distribution. The smaller number of joints more than compensates for any small increased difficulty in handling. In the earlier days of electric traction the carbon specified in many cases was as low as 0.35%, but with heavy traffic and steep gradients this soon proved too low. An average of 0.50% has been proved a happy medium, being sufficiently low to avoid fracture, even when bent by crowbars to a curve of 30 ft. radius, and sufficiently high to obtain a chemical composition producing a tough durable rail. To avoid the possibility of the fish-bolts working loose by vibration, they should be fitted with lock-nuts.

SPECIAL WORK‡—Perhaps in no other department of street railway construction have the British manufacturers made such improvements as in the case of frogs and switches. A comparison of the old, short cast-steel switch with the 13½-ft. switch rail now used will best demonstrate this. The latter can now be obtained either as a casting composed entirely of manganese steel, or of the type known as "iron-bound," which consists of pieces of ordinary rolled rails, the portion where the wear is greatest being fitted with a renewable plate of manganese steel, which is keyed down and finally run in with spelter; the various portions being consolidated with a strong binding of cast iron. Iron-bound frogs are constructed in a similar manner to the above. Automatic and movable switches are also fitted with tongues of manganese steel. The great advantage of using iron-bound switches and frogs is that uneven wear at the joint, due to difference in material, is greatly reduced, as the insert plate is splayed back and tightly fitted. The extended legs can also be curved a little, if necessary. A small percentage of the insert plates become loose, but this can be remedied by directing the flame of a blow-pipe on the spelter, taking out the plate and running in a fresh quantity of the cementing material; or the plate may be secured by driving in small hard steel wedges at opposite corners. The blow-pipe should be carefully directed, or there is danger of cracking the casting.

In a turnout, the switch rails are 13 ft. 6 ins. long, with a straight run on the left-hand side and curved to 200 ft. radius on the right. This throws the frog a little out of center, but allows the cars to recover from any jolting consequent on entering the switches before coming on the curves. For the same reason it is necessary to have a tongue of greater length than the wheel base. Where a passing track is situated on a hill it is better to arrange for a side turnout to be taken by the ascending car, leaving a straight run through for the descending car to avoid a probable accident in the case of a runaway passing through the turnout. For any kind of special work, two open switch rails for one track should be avoided, much smoother running being ensured by using an open and a movable rail together. The movable rail should also be on the side to which the curve runs. Thus, if the curve is to the right, the right hand rail should be movable or automatic, and the left hand point open. With this arrangement, the back of the wheel flange bears on the tongue, but when the movable point is on the other side there is a great tendency for the wheel flange to mount the tongue.

JOINTS.—The life of the rail is only that of the joint. A special joint device designed for the improvement of low joints consists of a metal bed-plate resting on the concrete, a steel "supporting plate" in which two holes are tapped, and two hardened steel bolts, which, on being screwed home through the holes in the supporting plate, engage with the bed-plate, and thereby lift the joint to any required position, and there support it. Any subsequent depression, due to the rolling load or any other cause, can be readily adjusted by the use of a box-wrench without any disturbance of the paving. In new track work, it is claimed by the inventor to entirely obviate the necessity of expensive steel fish-plates, their primary function, that of support, having entirely ceased. In place of fish-plates, what are really two large cast-iron washers are substituted, being held from lateral movement by two ordinary tie bars. Shorter electric bonds may also be used. In Manchester, where this joint support was first tested, several low joints were remedied, and are now in perfect condition after twelve months' test with a one-minute service of cars.

Too much attention has been paid to railway practice, although the conditions are totally dissimilar. In no other case has this proved so expensive as with the custom of leaving a space for expansion, and the joint unsupported. A joint cannot be too rigid, and the nearer a continuous rail is approached the smoother will be the running. The joint plate that allows for a cushion effect is a certain failure, as the depression becomes greater after a time, allowing the rail to swing. No room for expansion need be made in this country. Each rail should be hammered on the end to ensure the tightness of the previous joint. Many joints which have been left wide could be greatly improved by inserting a thin section of the rail. This would be held tightly in place by the fish-plates. Others are so bad that only by cutting out the joint and inserting a short piece of rail, varying in length according to the wear on either side of the joint, could any improvement be effected.

It was observed that a certain length of track

(Continued on page 255.)

*Abstract of a paper read at the annual meeting of the Incorporated Association of Municipal and County Engineers, Norwich, England, June 22, 23 and 24, 1905.

†Colchester, England.

‡A valuable paper on American practice in special work was printed in our issue of Aug. 3, 1905.—Ed. Engineering News.

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The recent eclipse of the sun has been the means of bringing out a new argument for the benefit of opponents of municipal smoke prevention. In describing the eclipse the St. Louis "Post-Dispatch" stated that the conditions for its observance were perfect in St. Louis, the sky being cloudless. It then observed:

> With the thin veil of smoke from East St. Louis factories to modify the glare it was easy to watch the eclipse without the aid of smoked glasses.

This condition, however, did not apply to the whole city, for:

> In the West End residence section hundreds arose on the call of their alarm clocks and spent an hour looking eastward through panes of smoked glass. These did not get the benefit of East St. Louis smoke.

The argument has often been advanced that smoky chimneys were the best possible advertisement for an industrial city, and we now expect to see it urged that such cities possess unusual advantages for eclipse-observing expeditions.

As a minor illustration of the good work done by the testing department of the National Fire Protection Association cooperating with the National Board of Fire Underwriters, and as a bit of information of possible value to employers of watchmen, we take pleasure in referring to a small circular just issued and which we understand can be obtained from the Underwriter's Laboratories, Chicago, Ill. The circular contains a list of watchmen's time recording apparatus, issued in August, 1905. These comprise central station system (one), local or private stationary systems (eight) and portable watch clocks (three). The central are considered better than the local or private systems. The trade name, name and address of the manufacturer, and the dates of the original examination and the latest re-examinations are given in each case. As intended above, this is only a minor illustration of the commendable tests carried out by the association named.

The dangers from overhead wires were illustrated in Chicago during a fire in a factory at Kinzie St., Aug. 21. The tracks of the Chicago & Northwestern Ry., Pennsylvania Lines and Chicago, Milwaukee & St. Paul Ry. run along this street (and are now being elevated), and at this point are crossed by a great number of electric cables and wires. The flames burned one of the poles standing beside the tracks, and as it fell the weight of the wires pulled down the pole on the other side, completely blocking the tracks at the busiest time of the morning rush traffic. The work of clearing away the tangle of wires occupied considerable time, being hampered by the fire. It is high time for our first-class and many of our second and third-class cities to get all wires underground, unless it be in outlying districts. In doing so, however, they should see to it that they do not surrender valuable rights and make difficult the future control of their own streets, as was done some years ago in Manhattan Borough, New York, and as has but recently been done in the case of the telephone wires of Chicago. As shown in the article on the telephone street settlements and telephones in Chicago, in our issue of Aug. 24, private interests come well nigh monopolizing the underground portions of Chicago streets for all sorts of purposes under the guise of getting telephone wires off the poles.

THE ALBANY STORE COLLAPSE AND THE OWNER'S RESPONSIBILITY IN RECONSTRUCTION WORK.

The coroner's action in the case of the Albany store collapse appeals to one's sense of justice as appropriate and necessary. The history of the accident discloses a surprising lack of the requisite care in conducting the work, for which fault the contractor and his foreman-in-charge must be held morally and legally responsible. The coroner has, accordingly, charged these two with criminal negligence, and has procured their arrest.

Good as far as it goes, this action on the part of the coroner, and the reasoning back of it, only partially cover the case. From the standpoint of the mere citizen as well as from that of the structural engineer, other phases of the accident appear which demand attention—widespread attention, we believe. The Albany collapse is not the first building accident in the history of our own times, and it will not be the last; nor will it be the last such accident that involves serious loss of life. But it presents in clearer outline than usual the chain of circumstances which characterizes most similar accidents and which is not, or only rarely, given due consideration.

We speak here of accidents that occur during reconstruction and alteration rather than of accidents in the building of new work. The latter have a different character from the former, and should be discussed separately. On the occasion of the cobhouse fall of the Darlington building in New York City a year and a half ago, we touched on some matters connected with accidents in new building construction. The present remarks are confined to the other case of alterations and repairs; let us say generally, of reconstruction; and it will be understood that they refer only to that class of reconstruction which in some stage affects the integrity or stability of the structure concerned.

Reconstructon work is subject to various unfavorable conditions peculiar to itself. Primarily, the work proceeds by progressive weakening of the structure rather than, as in new building, by progressive strengthening. Next, the conditions of stress set up in the structure during the work are generally such as were never contemplated by the designer; the stresses are distributed more dangerously. Further, there is usually but partial information about what lies behind the face of attack, and in many cases the anatomy of the structure is almost wholly unknown, so that the work necessitates striking blindly at what may be vitals. All the minor conditions of working are apt to be unfavorable: access difficult, space restricted, light bad, etc.; and in addition the work is not infrequently entrusted to hands lacking ability proportionate to the difficulties of the task. These unfavorable conditions, of which every piece of reconstruction contains at least a part, will be seen to involve the element of chance to a considerable degree. The conclusion is evident that, broadly speaking, reconstruction work always involves greater risks than do normal building operations.

Still greater risks, arising from more serious uncertainties, are met in special cases. Thus, in the case of old structures, not only may the nature of the construction be unknown, but the strength of the whole and of the component parts may be doubtful and undeterminable. Further, if the structure has been previously altered, extended or repaired repeatedly, it may be non-homogeneous to such an extent that the actual subdivision of loads and stresses among its parts can not be guessed even roughly; or, what is worse still, the structure may have become strained or cracked, and may verge upon instability, even before the attack of the re-builder. Where such extraordinary complicating conditions are met—and they are not very rare—the risk attending the undertaking is great and imminent, even with the best skill and care.

The fact that reconstruction work involves more than the usual risks of building, should dictate some general principles: The existence of considerable elements of chance should be fully realized by all parties concerned, architect, owner, contractor and public building authorities. Means should be taken, at all stages, to make certain that any mischance will entail minimum danger to life. In those cases where any of the more serious elements of complication are present, the view should be taken that from the first attack to the completion of the work the structure is unserviceable or even dangerous; it should be vacated and access to it should be denied to all persons except the contractor's men.

Corresponding to these principles, public and legal opinion must place responsibility for injury or loss of life, if an accident occurs, in part on those who, without due regard to the risk created by the reconstruction work, exposed the victims to the chance of accident or failed to warn them of their exposure. Both the employer of the contractor, who controls the premises where the work is done, and the police, building or other authorities, who are charged with the care of public safety, may be thus subject to blame if an accident occurs involving other lives than those of employees of the contractor.

In any case, whether an accident occur or not, a large moral responsibility rests on the owner of the premises who orders the work done. It is he who, before undertaking the work, must either by his own judgment or with the help of expert advice, form an estimate of the risks involved in the work; following this, it is again he who must take the necessary steps to limit the probable consequences of an unforeseen accident. The contractor is with reason held liable in so far as he has failed to use the necessary skill or care in prosecuting the work, but the consequence of accidents of pure chance or of cause not legally traceable to the contractor falls upon the owner. Even considering the case of accident due to the contractor's neglect, the owner is to blame if the extent of the disaster goes beyond the limits of the contractor's control. And the contractor is clearly unwise who, facing the possibility of accident by his own misjudgment or by neglect of duty on the part of his subordinates, knowingly assumes criminal and financial responsibility for life which it was the owner's place to safeguard by proper restriction of access or otherwise.

These views are not widely held; certainly they are not generally followed out. Their disregard, of which instances may be observed almost daily, leads to methods of procedure which increase the possibilities of serious accident. The Albany case illustrates this quite well. The conditions in that case, described more at length elsewhere in this issue, are summarized in the sense of the preceding as follows.

The work concerned a structure which was old, much-patched and badly non-homogeneous; in which the sufficiency of many component parts even when new was doubtful, on the basis of reasonable factors of safety; and in which any straining, or light and otherwise harmless settlement, might cause serious accident. The changes to be made under the contract involved the delicate procedure of undermining, removing and rebuilding the foundations of the main columns and walls. Most of the complicating conditions previously enumerated appear to have been present in this case, and if present in sufficient degree, the building should, as above argued, have been adjudged dangerous during the work and should have been vacated. The situation was met in a characteristic way: The owner, after concluding that a certain extension was desirable, had an architect prepare plans showing the new work and such portions of the existing building as were immediately affected, and giving the main dimensions of the parts to be built. Such plans, it will be recognized, represent nothing more than an ideal, a future condition; they do not pretend to prescribe or advise as to the intermediate steps, or to say whether or what

risk may be involved in reaching that future condition. It is to be presumed that the owner knew, or should have known, that the reconstruction of foundations made his building during the work much less safe than it was originally or would be afterward. Moreover, he knew better than any other person that his building was old, patched, and employed for a service not originally contemplated. Knowing this, by the exercise of reasonable judgment he should have become aware that the proposed work would create a large risk to occupants of the building. At the very least, the facts should have led him to seek competent, disinterested engineering advice as to the degree of the risk involved. There is no evidence that such advice was procured. The work was placed without reserve in the hands of a contractor, and the owner appears to have calmly rested upon the skill and foresight of the latter to stand between the safety of the unwarned clerks and customers on one side and the dangers of the uncertain foundation work on the other. The building continued in service as a department store throughout the work.

The public authorities in charge of building operations must have been equally cognizant of the conditions which made this building a special risk. Yet no more than the owner did they take steps to warn the employees of the store and the outside public of this risk.

These conditions are emphasized not with the purpose of charging special neglect, but to describe conditions that are extremely common, if not universal. And, before the law, all parties probably stood secure, provided the contractor used reasonable care in his work. The architect was employed merely to draw plans showing finished work, and he is therefore out of the case. The owner put the work in charge of a man skilled in such work, and turned over to him all responsibility for its safe execution. The building authorities similarly were bound to see only that the finshed work would be secure, and (in some cities) that the general procedure of the contractor was proper and workmanlike. The contractor, for his part, would be liable only for neglect. If an accident occurred for which the law held him liable, then the loss of lives which the owner had admitted to the premises would fall upon him, the contractor. That was his gamble. On the other hand, suppose a fatal accident had happened due to one of the many risks inherent in the work, without convincing neglect on the part of the contractor. Nobody would have been liable; it would be viewed by the law as a pure accident for which no one could be blamed.

As it happened, the contractor lost his gamble. The accident was caused, so say the investigators, by failure to exercise ordinary caution and engineering judgment in a difficult portion of the work. The blame, therefore, rests primarily upon the contractor, to an extent which the courts will doubtless determine. The share of responsibility that rests on owner and building department in the present case will in the eye of the public vanish from sight.

Ultimately, we feel certain, recognition of such responsibilities must become general, and must be crystallized either by law or by custom into a force working for public safety. That progress in this direction has been and will be slow is not hard to understand. While accidents to building work during construction and reconstruction are not infrequent, the proportion marked by loss of life is relatively small. Only the latter, of course, are subjected to public investigation, while the others, if studied, remain business secrets of the contractor. Two accidents virtually identical in character and extent, only one of which involves loss of life, may occur in the same neighborhood at about the same time; yet only the fatal accident is studied, while of the other even the parties directly concerned may never learn the full particulars. These conditions have produced two results: first, that our accumulated stock of knowledge and sound opinion concerning building accidents is very small; second, that the more serious and fully investigated accidents become invested with the halo of the extraordinary, the never-happened-before-or-since. Both results are unfortunate. They militate against progressive educational reduction of the chances favoring such accidents, and, what amounts to the same thing, against strict accounting for their serious consequences; and they prevent the growth of proper estimation of the risks inherent in the work.

REINFORCED CONCRETE CONSTRUCTION IN FREEZING WEATHER.

Is it safe to do concrete work in freezing weather? Business conditions often require building work to be done in winter and in our northern climates this means that freezing temperatures will prevail during a considerable portion of the period of construction. So far as strength and safety are concerned this does not matter much in steel and masonry building construction; even concrete work in mass in foundations and footings is not seriously affected by freezing temperatures, but when concrete reinforced with steel is used for thin walls, columns and girders, winter work introduces real dangers which must be guarded against by the engineer. This fact is fully realized by the leading builders in reinforced concrete and they often go to great expense to protect their work from damage, as may be seen from the article on another page of this issue describing a large manufacturing plant constructed near Rochester, N. Y., during the past winter.

Returning to the opening question, laboratory experiments show that concrete which does not undergo freezing temperature until final set has taken place, or which, if frozen before it has set, is allowed to complete the setting process after thawing without a second interruption by freezing, does not suffer loss of strength or durability. So far then as quality of material is concerned it appears that it is only repeated freezings and thawings during the process of setting that need be feared in concrete work. If the builder can make sure that his concrete work freezes but once during the period of setting he need not fear that the quality of his material will be inferior when setting is ultimately completed, but he must of course bear in mind that while the wall or beam remains frozen and until it finally sets it can perform no part of its function in resisting stress.

While the problem of safety in performing concrete work in freezing weather is not merely the question how to prevent physical or chemical injury to the material itself, this is nevertheless the first matter to be determined. Bearing in mind the teachings of laboratory experiments, the following means of avoiding danger present themselves: The first is so to treat the materials or to compound the mixture that freezing will not occur at normal freezng temperature or else will be delayed until the concrete has set. The second way is so to house in the work and artificially heat the inclosed space that its temperature never falls as low as the freezing point. A third way is to let the concrete freeze if it will and then by suitable protection and by artificial heating produce and maintain a thawing temperature until set has taken place.

The measure that has been most frequently adopted of the three mentioned is to prepare the materials or mixture so that freezing is delayed. It consists either in heating the concrete ingredients or of adding to the mixing water some compound which lowers its freezing point. The distinction between the two is that heating the concrete materials merely delays the freezing for a time while the admixture of chemicals absolutely lowers the temperature at which freezing is possible.

Specific information as to the efficiency of heating is difficult to arrive at. There are no test data that show how long it takes a concrete mixture at a certain temperature to lose its heat and become cold enough to freeze at any specific temperature of the surrounding air, and a theoretical calculation of this period is so beset with difficulties as to be impracticable. It would be worth while perhaps for some of our college laboratories to determine by test how long freezing is delayed at various temperatures below 32° F. by heating the concrete ingredients. Strength tests of concrete made with heated materials have shown clearly enough that the heating has no influence worth mentioning; this point needs no further study, but tests to determine the period of delay of freezing might give results of considerable value to builders.

The addition of some chemical to the mixing water is more frequently resorted to than is heating, principally no doubt because of the simplicity of the process but also because the user can know with some definiteness what measure of protection he may count on. The ingredient most commonly used is salt, the addition of which to the mixing water lowers the freezing point about 1½° F. for each per cent. added. Calcium chloride may also be used; it gives a solution having a somewhat lower freezing point than salt brine. Salt has the effect of slightly reducing the early strength of cement, but does not affect the ultimate strength when used in quantities not exceeding 10% by weight of the mixing water. Some authorities in fact place the safe percentage at a considerably higher figure. Salt also delays the setting of cement. The effect of calcium chloride on strength and activity is not known; tests have been made which show that its addition considerably increases the strength of lime mortars.

Heating the concrete ingredients or dosing the mixing water with salt or calcium chloride have at best but a limited range of effectiveness. They may prove useful precautions at temperatures not greatly below freezing but at very low temperatures they cease to be practicable; a 10 per cent. salt solution for example freezes at about 17° F. and a 20 per cent. solution at 2° F. If winter work is not to be interrupted at frequent intervals in our northern climates the engineer must seek some more effective means of protection than are afforded by the measures first mentioned above. As indicated, this search has resulted in the adoption of a radically different principle of protection; instead of attempting to nullify the action of cold by special treatment of the concrete mixture the aim is to shut out the cold by the familiar means of housing and artificial heating.

Certain safety is gained by housing in concrete work and heating the inclosed space, but it is gained at considerable expense. It is no small undertaking to instal and operate such an arrangement as is described in the article already referred to as printed in another column of this issue. Only the stress of unavoidable circumstances renders it endurable. Two ways are open to the builder to conduct his housing and heating operations: he can house in the site of his work first and place his concrete at thawing temperatures, or he can first place his concrete, allowing it to freeze if it will, and then inclose and thaw out his frozen work so that setting and hardening may proceed uninterruptedly. A notable example of the first-mentioned mode of procedure was furnished by the construction of the dam of the Chaudiere Falls water power plant in Canada, described in Engineering News of May 7, 1903.

For reinforced concrete building work the construction of the work before housing it in possesses obvious advantages. In fact it may be regarded as little short of impracticable to inclose such structures prior to construction. With the concrete in place a very simple temporary housing so designed that it can be applied to section after section of the work is made possible. This fact is excellently illustrated by the concrete building work described elsewhere in this issue. A very simple arrangement of canvas curtains and light wooden shutters provides a thorough housing and one which can be used over and over again at a very small cost for removal and re-erection. It is also an elastic arrangement in the respect that it may be adapted with equal readiness to large or small structures or to the whole or to only a small section of the building. This is a practical advantage of importance since it enables the work to be prosecuted without extra forms to support the concrete while its hardening is delayed by freezing.

In reviewing what has been said it is evident that at best the engineer has an awkward task in safeguarding concrete work done in freezing whether. It is a pity that this is so since reinforced concrete offers so many advantages for certain classes of buildings that so important a drawback stands out in alarming prominence

GARBAGE DISPOSAL BIDS AND POSSIBILITIES AT NEW YORK CITY.

A notable reform in making ready for a garbage disposal contract has been inaugurated by the New York Department of Street Cleaning. Heretofore it has been the practice in New York, and in fact, the well-nigh uniform practice elsewhere in the United States, to give such scant time for the preparation of bids and for building disposal works as to virtually exclude competition except only a contractor with a plant already built or one who felt sure that the powers that be would extend the time of making ready for receiving garbage dared to put in a reasonable bid. Under the New York letting now proposed contractors are to have until next November to prepare their bids and the plans that must accompany them, and until Aug. 1, 1906, to build disposal works. The disposal facilities, it may be added, must be capable of removing from the water front and of treating 1,000 tons of garbage per day; garbage here meaning organic wastes and not including ashes, tin cans and miscellaneous refuse.

The specifications for the work in question show no preferences whatever as to methods of final disposal, thus permitting bids on either cremation or reduction works.

Heretofore promoters of garbage crematon have made but sorry showings whenever a large American city has asked for bids for garbage disposal plants. They have generally been lacking in capital, in engineering ability and in furnaces of demonstrated economy and sanitary efficiency. But after so many years of experimentation (the first American garbage furnaces were built some twenty years ago) certainly American garbage furnace builders ought to have something creditable to show. We hope that will be the case. That the American furnaces will have to meet strong competition from garbage reduction plants there can be no doubt, and it also likely that there will be competition from some of the leading types of British refuse destructors. The time so wisely given for the preparation of bids and the construction of disposal works favors wide competition, with fairness to all bidders, and promises to be highly advantageous to the city.

Having been unstinted in our praise of certain features of this competition we trust we may be pardoned, if pardon is necessary, for calling attention to certain fundamental principles of municipal economy which seem to be violated under this and numerous other short-term contracts for municipal services where those contracts involve heavy outlays for plant not elsewhere utilizable and which the city does not agree to take off the hands of the contractor if the contract is not renewed. In this particular case, for reasons which need not be discussed, the city has for the present decided against municipal ownership of a garbage disposal plant. But is it not perfectly obvious that under the guise of yearly payments for garbage disposal the city is really making itself liable to pay for the disposal plant as well, and that without gaining possession of the plant? The contractor may be left, at the expiration of the contract, with an expensive plant for which he will have no further use. Knowing this at the time of preparing his bid of course he makes his yearly price for work done sufficiently high to cover the construction cost of his plant. If he does not do this then he simply gambles on the chance of a renewal. Few bidders will do this, and most of the few, as a rule, count on political influence to gain a renewal of the contract. Under such conditions it is obvious that wide and free competition is smothered and that the cost of the service to the city is increased.

Unfortunately, this is not all, particularly in the case of garbage disposal. The New York competition now thrown open is not really open to all manufacturers and builders of garbage furnaces and of garbage reduction plants; only general contractors can compete; or such manufactures of garbage disposal apparatus or proprietors of patented processes as can, directly or indirectly, go outside the manufacturing and building field and take contracts for the transportation and the final treatment of garbage. Ample capital and business organization for building and selling garbage plants will, of course, be wholly inadequate for undertaking disposal contracts, and so the best of processes may be shut out from or greatly handicapped in entering the New York or any similar garbage competition.

Thus far the garbage furnace men have suffered the most from the conditions just outlined, and consequently reduction processes prevail in nearly all large American cities that have adopted improved means of disposal. The reduction companies can attract capital because they can hold out the prospect of obtaining large profits from city waste; and they can hold capital because they can get bonuses from the cities for disposing of those wastes, notwithstanding their claims for the value of the by-products of garbage disposal. The furnace people, thus far, have had virtually nothing to offer anyone except furnaces; that is, in this country. It is high time for our American furnace builders to awaken to the advances made by British engineers and refuse destructor manufacturers and see if both the efficiency and the financial attractiveness of American garbage furnaces cannot be increased.

Heat utilization is the winning card of the British manufacturer. While we have always been skeptical of the commercial possibilities of utilizing heat from American refuse we would gladly have that skepticism removed, if possible, and have more than once urged that some American city take steps to ascertain the heat-raising value of American refuse. We hoped this would be done before or in connection with the New York contract, but what encouragement is offered to that end under the general terms already outlined? It is enough to expect a contractor to build and operate garbage furnaces on a five-year gamble without expecting him to add an expensive heat-utilization equipment; but perhaps some one will have the temerity to do so and will be lucky enough to win fame if not riches through being the pioneer in the much-needed reform of garbage disposal in America. If so he can thank Commissioner Woodbury for giving him ample time to raise capital, prepare plans and bids and build his garbage disposal works.

LETTERS TO THE EDITOR.

The Cubical Contents of a Wheelbarrow.

Sir: Referring to "Engineer's" letter on the cubical contents of a wheelbarrow please note the following data:

(1) A cement barrel contains 380 lbs. net of cement and has a volume of 3.45 cu. ft. Cement in this form, therefore, weighs about 110 lbs. per cu. ft. In a bag or loose it is a good deal more bulky.

(2) Sand as handled in wheelbarrows weighs about 85 lbs. per cu. ft.

(3) Stone as handled in barrows weighs about 100 lbs. per cu. ft.

(4) An ordinary contractor's wheelbarrow holds about 120 lbs. of sand and about 130 lbs. of stone.

(5) Concrete should always be proportioned by weight and not by volume.

Let "Engineer" get a careful average on the weight of sand per barrow and on the weight of stone per barrow and proportion his mixture accordingly.

Yours truly, F. H. Lewis.

Staunton, Va., Aug. 25, 1905.

Sir: Referring to the communication from "Engineer" relative to "The Cubical Capacity of a Wheelbarrow," in your issue of Aug. 24, will say that owing to the fact that the sizes of wheelbarrows vary considerably, it will be found to be a good plan, when beginning a job, to dump the quantity of cement (in this case two bags) for one batch, into one of the wheelbarrows to be used; noting the size of load, and thereby guessing the quantities of sand and stone or gravel contained in the same-sized wheelbarrows. Or another way to arrive at the same approximate result is to load a wheelbarrow with sand, and see how many empty cement sacks it will fill. After making these experiments your correspondent will doubtless conclude that he can use only two barrows of sand and four of stone to two bags of cement for a good 1:3:6 mixture. Yours truly,

Chas. H. Miller.

727 East End Ave., Pittsburg, Pa., Aug. 28, 1905.

(The query put by "Engineer" in our issue of Aug. 24 was not merely what the capacity of a wheelbarrow is, but what the custom is among engineers as to measuring concrete where barrows are used. Of course the claim made by the contractor that a 1:3:6 concrete means 2 bags of cement to 3 barrows of sand and 6 barrows of stone, was a claim made either through ignorance or as a "bluff." There is no custom that sanctions any such absurd claim. However, since it is the custom of many contractors to measure the sand and stone in wheelbarrows, it devolves upon the inspector to see to it that enough cement is used to secure the necessary proportion of 1:3:6. This can not ordinarily be secured unless 3 bags of Portland cement are counted as being 1 wheelbarrow load, for it is well known that a laborer can wheel at least 300 lbs., in a barrow, even up a runway having a gentle incline, provided the runway is smooth and clean. Now, with sand or stone weighing 90 lbs. per cu. ft., a good wheelbarrow load is approximately 3½ cu. ft. Such a load, it is true, can not be wheeled up a steep incline, or over a runway covered with dirt; but there are plenty of records showing that such loads are common in concrete work. If a bag of cement is called 1 cu. ft., which is frequently the case, we see that 3 bags will no more than make the equivalent of a large wheelbarrow load of sand. Of course there are conditions where men can not be counted upon to wheel such heavy loads, and it then becomes necessary to reduce the number of bags of cement, if this method of measuring is to be used.—Ed.).

The Mosquito Theory and Yellow Fever at New Orleans and Elsewhere: Continued.

Sir: Your reply to my letter of Aug. 17 does not read like your usual spirit of fairness. However, regardless of satirical answers, sarcasms, etc., which, by the way, the writer expected, I do not believe the people of the South will ever believe in the immunity of New Orleans from yellow fever until it is in a thorough sanitary condition, as they are and have been trying to make it. I will venture to say that amongst people accustomed to yellow fever there is not one layman in twenty or one doctor in ten that really believes in the mosquito theory; it is however frightening the timid ones. Don't you think the publication of my letter of transmittal was a slight breach of confidence?

Yours very truly,

Little Rock, Ark., Aug. 27, 1905. Pro Bono Publico.

(Our comments were designed to be in the same good-natured vein as was the letter from our correspondent. If they were in any respect unfair we regret it.

The letter of transmittal with the real name of the writer omitted did not seem to betray any confidences, but the implied rebuke in the closing sentence of the letter published just above will be accepted for the possible benefit of future correspondents.

We thought we made it clear that putting New Orleans "in a thorough sanitary condition" is a consummation devoutly to be wished, and that mosquito extermination is a part of the task. —Ed.).

Masonry Dams in Narrow Rock Canyons; or Wing Dams

Sir: The article in Engineering News, Aug. 10, 1905, by Messrs. Wisner and Wheeler, and the conclusions and results have been noticed by the writer, who previously had given considerable attention to this subject, and by thorough investigation has come to certain conclusions, which have been presented to some of the engineers of the U. S. Reclamation Service, who are usually consulted in these matters. While this investigation is kept at the disposition of anyone, particularly interested, it seems to me that a further discussion on the subject of arch dams has at least as far as narrow gorge dams are concerned, very little further interest. I mean, that the principle of construction herewith presented by general diagrams, and which may properly be called the wing-dam principle, is by far more adapted for these cases, while for wide valleys the horizontal arch principle will yield hardly any economic advantage anyhow.

The dam recommended is divided in two wings by a central expansion joint (of course water tight) running from top to bottom. The upper, wider portion, may properly be closed by an ordinary gravity dam as shown. The lower portion by the wing dam proper; each wing upstream with circular or polygonal, down-stream with plain or arched face, transmits the water pressure in a horizontal direction immediately on the rocks properly stepped to receive the pressure. It will be seen that the strains on the massive block of masonry are very small, and hence either the quantity of concrete or masonry may be reduced by suitable spare-holes, 30 to 40% without the least danger; or concrete with less cement may be used. However, even without this reduction, the quantity of masonry is in narrow valleys of 100 to 150 ft. width

considerably less than has been deemed necessary by the engineers of the U. S. Reclamation Service for the arch dams.

In such an important structure as a reservoir dam, the cost is naturally a secondary question, however, and it is more the search for superiority in strength and durability, and especially independence from uncertain theories and good-luck methods, which has occupied the writer.

I suppose that the results, in the article above alluded to, could be criticised by a better pen, hence let me restrict my remarks to the following, which seem essential in this connection:

(1) It is not at all certain that the changes of temperature assumed will not be greatly exceeded.

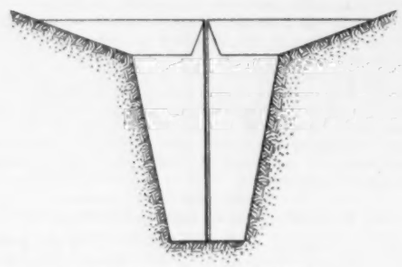
(2) Even with these limits of temperature, strains result, according to said article, which cannot be trusted to the tensile strength of the material; hence, cracks will probably occur, as they have been observed in other cases.

(3) If instead of the beams in a vertical direction, which are much longer, the beam action of the concrete in a horizontal direction, which really is much more efficient and important than the former, had been figured out, strains much greater would have resulted than in a vertical direction.

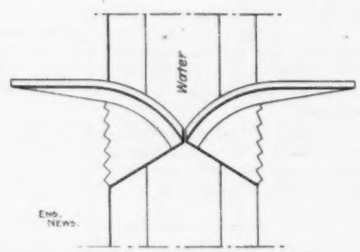
I trust the above three claims will be admitted by anybody who has studied the subject.

In the wing dam no such dangerous action of the temperature can take place, each wing being free to expand independently, and if anywhere, it will be in this case that the dam forms a true monolith as firm as the hillsides.

The danger from water pressure due to fissures in the hillside, and tending to shift the wings towards the



Downstream Elevation.



Plan.

center, can easily be avoided by a number of inexpensive bore holes and drainage down-stream.

If with respect to this somewhat novel construction some readers would meet other critical points, which have not been mentioned or not foreseen at all, it would be useful and certainly agreeable to the writer to see them discussed in your columns.

Very respectfully,

Charles R. Steiner,
Assistant Engineer, U. S. Geological Survey.

Denver, Colo., Aug. 23, 1905.

Notes and Queries.

G. D. W. asks for an expression of opinion on the maximum allowable spacing of reinforcing bars in concrete floor slabs. Practice throughout the country seems to vary widely on this point. Several prominent engineering and construction companies allow a spacing of from four to six times the effective depth of slab. There are others, however, that allow only about two and one-half times the effective thickness.

R. W. B., of Alexandria, La., presents the following inquiry, which we submit to our readers:

Will you or some of your readers kindly advise me as to the proper manner of establishing the center of a Section of land where the North and South lines each change their bearings at the quarter corners and have different lengths? Should the center of the Section be where two straight lines connecting the opposite corresponding quarter corners intersect, or should it be equidistant from the opposite corners?

THE EVOLUTION OF THE BABYLONIAN BRICK.

By Prof. Edgar James Banks.*

There is a Hebrew tradition that when the early people of the world were in the plain of Shinar, which in later ages was known as Babylonia, they wished to construct a tower, but in the alluvial soil they could find no stones. Necessity was the mother of invention, and from clay they formed bricks, burned them, and laid them with the pitch from the neighboring hot springs.

The excavations which the University of Chicago has been conducting at Bismya, in Central Babylonia, the most ancient ruin yet discovered, have explained the origin and development of the Babylonian brick, and therefore of bricks in general. The temple hill at Bismya is a mound of ruins reaching twelve meters or more in height above the surface of the desert level and the sand which is entirely free of traces of habitation. The highest stratum of this heap of ruins contains bricks bearing the name of Dungi, a king who lived 2750 B. C. Less than a meter beneath them, were the bricks of the famous Sargon, who, a few years ago, was regarded as the oldest king known to history. His date is generally put at 3800 B. C. Two meters below the surface were walls constructed of the so-called plano-convex bricks assigned by Assyriologists to 4500 B. C. In the remaining ten meters of debris were the remains of still earlier civilizations, and the ruins of the lowest stratum we can only estimate to represent a period not far from 10000 B. C. In this vast accumulation of ruins, embracing so great an extent of time, were discovered nearly fifty varieties of bricks, illustrating clearly their evolution from the beginning to the brick which is now employed by the modern builder.

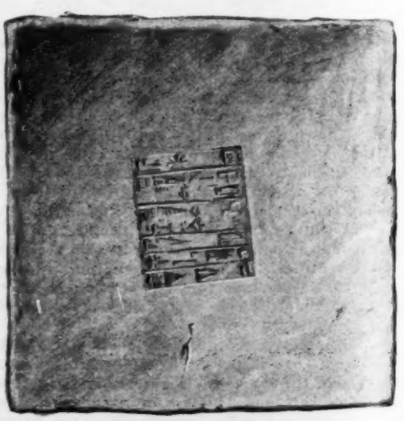
In the several lower strata of the temple, the walls which appeared were of unbaked and unmolded clay, and except to the trained eye, they were indistinguishable from the surrounding dirt. Similar walls are still employed in the huts of the modern desert Arabs. At a higher level, representing a period long before 4500 B. C., were found small blocks of white limestone, the only durable building material which was known. Although from the earliest times the Babylonians were acquainted with the burning of pottery, it seems that it was not until toward the beginning of the fifth millennium B. C., that it occurred to them that bricks could be burned, and it was probably the difficulty of transporting the stone from a distance which brought the idea to their minds.

The first bricks were mere chunks of clay, roughly formed by the hands, without a mold, and laid upon the ground to dry before being baked. Thus, they were flat upon the bottom, with low edges, rounded corners and a high convex upper face. To adopt a small wooden mold, resembling a bottomless box of the desired size and to mix the clay with straw, were the next steps. The first bricks measured about 25 × 13 centimeters. They gradually grew larger, bricks measuring 22 × 15, 24 × 16, 27 × 18, 35 × 24 and 37 × 24 centimeters came from the later periods. The plano-convex bricks were usually laid upon edge, herring-bone wise, and set in mud or bitumen. Lime from the hills to the east of Bismya was employed as mortar at a later date.

The brick inscription, or mark, seems to be as early as the brick itself, and it kept pace with it in its development. In ancient Babylonia, it was not the manufacturer who stamped the brick, as in modern times, with his name to advertise his business; it was the king who would perpetuate his name, or distinguish his work from others by adding to it a special mark. The first marks upon the bricks came from the workman's fingers, probably accidentally, as he drew his hands over the clay to smooth it. The finger marks gave the suggestion, and soon, a large, deep imprint of the thumb appeared regularly upon the rounded surface of the plano-convex bricks. Other builders varied the marks by punching in the upper surface, one or two or three holes, with the tip of the finger, or with the end of a small round stick.

It was only when the mold was adopted that a systematic method of marking appeared. The royal builder who originated the system distin-

A GROUP OF BRICKS FROM BISMYA.



A Square Brick Stamped With an Inscription of Ur-Gur of 3800 B. C.

The brick measures 33 × 38 × 8 centimeters. The inscription reads literally:
Ur-Gur,
King of Ur,
King of Kengi,
who, the temple
of Bel,
has built.

*Field Director of the Babylonian Expedition of the University of Chicago. Summer address, Woodbury, Vt.

guished his bricks by having his workmen draw a finger lengthwise along the upper surface, forming what I have designated as the one-grooved brick; the next builder, to distinguish his work from his predecessor's, drew the groove diagonally instead of lengthwise; the third drew two diagonal grooves, intersecting each other and forming a St. Andrew's cross; the fourth adopted two parallel lines as his distinguishing mark; the fifth drew the two grooves diagonally, and the sixth crossed the grooves, forming a double St. Andrew's cross. The system continued in a similar manner; bricks of three, four and five grooves in their various positions appeared in the strata nearer the surface.

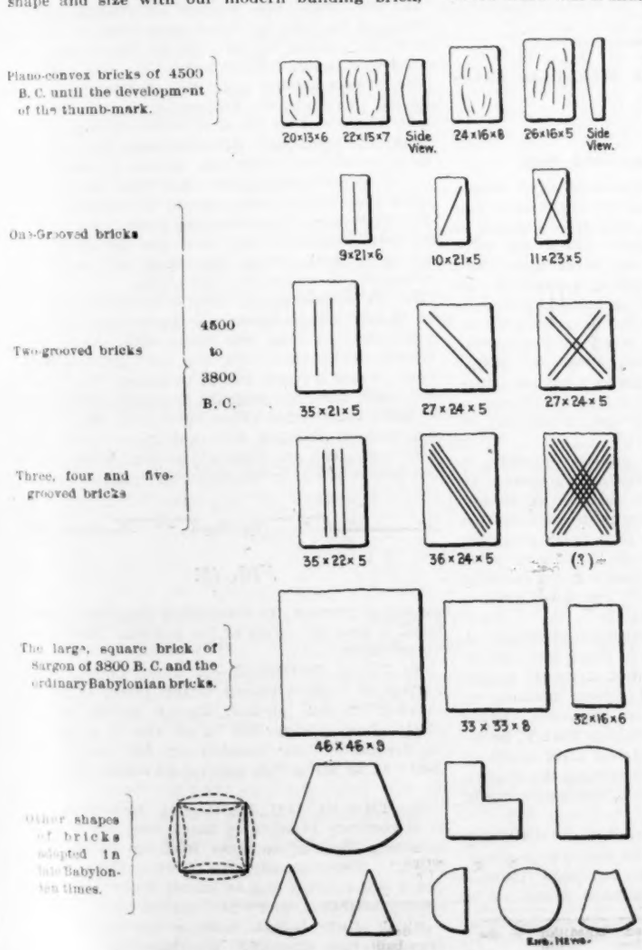
It was during the reign of the great builder, Sargon, of 3800 B. C., that the long, grooved brick developed into the immense square brick measuring 46 × 46 × 9 centimeters, and also in his time the grooves gave way to the more satisfactory inscription containing the name and titles of the king, and the name of the building in which the brick was employed. The inscription was sometimes written, but more frequently it was imprinted with a terra cotta stamp. Three brick stamps of Naram Sin, the son of the famous Sargon, were discovered at Bismya.

The square shape given to the brick by Sargon was adopted by all of his successors, but the size rapidly diminished to one which averaged about 30 × 30 × 6 centimeters, and remained so until the end of the Babylonian Empire. The same shape was adopted by the Persians, continued, although somewhat smaller in size, by Haroun er-Rashid, the hero of the Arabian Nights, and today it is the only shape used in Mesopotamia.

Although maintaining the shape of the bricks, the Babylonians varied it according to special requirements. They made half-bricks, identical in shape and size with our modern building brick, and to the ordinary person, indistinguishable from it. There were triangular bricks, truncated triangular bricks, circular and semi-circular bricks for the construction of wells and columns, bricks with a square cut from one corner, bricks with one or more edges concave or convex, and a variety of others to suit the requirements of the architect.

The brick inscription also continued to the end of the Empire, and was adopted by the Persians and even by the exiled Jews who built cities in Babylonia.

Of the interesting discoveries which have been made in the old city of Bismya, that of the evolution of the brick is not the least important. Not only is it an interesting side-light upon the study of the primitive civilization of man, it is a discovery of the greatest importance to the Assyriologist, enabling him to distinguish at a glance the relative age of any early Babylonian ruin, if only a fragment of a single brick be at hand.



OUTLINE SKETCH OF VARIOUS BABYLONIAN BRICKS.

ENGLISH STREET RAILWAY CONSTRUCTION.

(Continued from page 250.)

was badly out of alignment, due to being exposed to the sun previous to paving and concreting. The rivets were therefore cut out, the fish-plates taken away from one joint on each rail, and the rail ends allowed to slide past each other. In a short time there was an expansion of 4 ins. showing. The track was then concreted to within a short distance on either side of the released joint, which was afterwards spliced and concreted late in the afternoon. Once the flange was embedded in concrete, it was found that, although the rest of the rail was exposed previous to paving, the expansion was negligible, being only apparent by a fine crack in the concrete over the flange at a point where there was a sharp curve. A slight amount of creeping will be encountered, mostly on the hills, but can be neutralized by placing cross plates in the middle of each rail.

TIE-BARS.—But little saving is effected by using tie-bars notched at one end and screwed at the other, and they are not so efficient as those screwed at each end. When finally easing the track in line with bars, the notched ends slip, thus altering the gage. It should be insisted that all tie-bars comply with a certain standard of strength; those supplied by a certain maker were so weak, that during the night, owing to contraction of the rails at a curve, the tie-bars buckled.

BONDS.—In choosing the type of bond, preference should be given to one which can be re-used in case of repairs, etc. Plastic bonds, inserted between the fish-plate and web, have been proved practically a failure, losing a large percentage of conductivity after a short time, besides requiring careful handling owing to their poisonous composition. Cross bonds should be placed at intervals of 150 ft. on the straight track, and long bonds over the frogs and switches in addition to those provided for an ordinary joint.

DRAIN RAILS AND BOXES.—There is no advantage in using drain rails in preference to boxes, and their use merely increases the number of joints, and causes additional wear due to difference in material. Trapped drain boxes are extensively used, but seem a little unnecessary where the sewers are ventilated by means of perforated man-hole covers. A slot cut in the bottom of the groove discharging over a square box dished down to the outlet would carry off the water quicker, without the same liability to become choked with sand, etc.

LOCATION.—Having prepared an accurate plan of the route, the track may be plotted on, and the radii of the various curves found. Much unnecessary time is ordinarily wasted by setting out the whole of the center lines by the theodolite. The following rapid method of setting out ordinary curves has been used extensively by the author on a recent contract. The ends of the curve are tied in from some defined points on the street line, and the versed sine is obtained from the well-known formula:

$$-\sqrt{R^2-\left(\frac{1}{2}C\right)^2}$$ where R = Radius and C = chord.

The above method can, of course, be utilized for setting out curves, etc., where the radius is not known, by assuming an offset at the center and proceeding as before. Where the chord is long, the poles may be sighted in straight line by the theodolite or other telescopic instrument.

Portions of straight track between two curves in the same direction should be avoided, or a very unsightly appearance is presented, the termination of the curve being very apparent. A flat curve between the two sharper ones will greatly improve the appearance of the line in such a case. Between reverse curves, however, it is an advantage to have a short portion of straight, otherwise the curves appear so distorted on the ground as to be meeting at a point instead of tangentially. If several flanging rods are put in, any apparent deviation from the true line can be adjusted to the eye, saving a great amount of easing of the rails when laid to take out any such abrupt change of line.

For double junction and other special work the system of spiraling the curves is now generally adopted. A central circular curve is decided upon, from the termination of which the line is eased into the straight by a succession of short curves each of larger radius than the last. For example: A curve with a central radius of 39 ft. is gradually diminished to one of 429 ft. before running tangentially into the straight at a point 27 ft. 6 ins. from the termination of the central curve. By reference to tables, the offsets and lengths can be ascertained to suit various central radii. Where the central radius is not thereby made too small, one of the best methods of passing a corner is by means of a parabolic curve, in which the radii are varied from center to termination at the straight, thus avoiding the appearance of a "knuckle" at the latter point, which is always so apparent when a curve of uniform radius is set out.

Curves are not unknown on which the Board of Trade has refused to allow two cars at one time, due to the fact that insufficient allowance has been made for the overhang of the inner car during progress round the curve. The necessary allowance for the overhang of ordinary double-deck cars on curves is obtained by finding the versed sine formed by a chord of 22 ft. cutting the various curves, and adding the small versed sine made by the overhang of the wheel-base of the outer car. This allowance is shown in Table I. The chord of 22 ft. is the length of straight on the car, beyond which the overhang is not affected. For a 40-ft. curve, with a car 6 ft. 7 ins. in width, and 4 ft. 8½ ins. gage, the minimum distance between centers of tracks would be as follows:

	ft.	ins.
Overhang of car on straight track	1	10½
Extra overhang on curve	1	7½
Minimum clearance allowed	1	3
Gage	4	8½
Distance between centers	9	5½

The overhang may also be obtained by using a piece of cardboard the shape of the car, having cut out a rectangle the size of the wheel base and gage, and fitting it on to the curves of the required radii. The gage around a curve should be widened according to the radius, as shown by Table II. To keep a presentable cross section of street it is not always possible to give the necessary amount of elevation required for certain speeds around curves. It is especially important to approach as nearly as possible the elevation required, where a curve occurs at the foot of a gradient. Applying the formula for centrifugal force:

$$\frac{W V^2}{G R}$$

then, where V and G = velocity and force of gravity, respectively, in feet per second, and H, L and R = elevation, gage and radius, respectively, in feet, the sliding force towards center = centrifugal force, or

$$\frac{W H}{L} = \frac{W V^2}{G R}$$

Therefore

$$H = \frac{V^2 L}{G R}$$

With 4 ft. 8½ ins. gage, and a curve of 50-ft. radius, the elevation necessary for a speed of 6 miles per hour works out at 0.208 ft., or 2½ ins., thus emphasizing the need for cautious running round curves where the necessary elevation may not be obtained owing to reverse cross-fall of street, etc.

Where single track construction is adopted, care should be taken to place the turnouts in such positions that there is uninterrupted sight from one to the other, or a troublesome system of electric signaling has to be resorted to. Even then, however, cars will occasionally meet on the single line, causing delays.

Levels should be taken with some accuracy, and especially cross sections, in order to determine the amount of cross fall to be given at any particular point. With ordinary double track on the straight, and normal cross-fall of street, a cross-fall of ¾-in. may be given from inner to outer rail; and a camber of ¾-in. on the paving between the rails. An even contour may be obtained, where the track and sides are paved with wood, by keeping down the outer rail 1½-in. and giving ⅜-in. camber on the paving between each track. In many towns there is a great tendency to keep the paving from rail to curb too flat; a cross-fall of ⅜ and ½ in. to the foot for wood and granite paving, respectively, is not excessive, except for steep gradients, where the cross-fall may be reduced.

While toothed margins are more difficult to keep macadam up to, they are less likely to have a deep groove at the edge of the paving. Joints of paving should be as close as possible in order to avoid the excessive wear which accompanies wide joints by wheels jumping from one side of the joint to the other, breaking off the edges and thus causing the joint to become wider and wider.

TRACK LAYING.—The method of first raising the rails with bars, and, while supported at the required levels, packing above and below the rail flanges with concrete in one operation, is now generally adopted, and has much to be said in its favor. If the concrete is not too wet, a solid bearing can be obtained for the underside of the flange, and the concrete above resists lateral, vertical, or creeping movements. In smaller towns, where a paving block 4 ins. in depth can be used, the depth of concrete over the flange necessary for this purpose can be obtained. In larger towns, where a 5-in. block must be used, the same result could only be obtained either by deepening the web, and consequently weakening the rail to some extent while increasing its weight, or by cutting the block.

The old method of laying the concrete bed first, and then packing under the flange with cement and granite chippings, has been proved to cause endless annoyance. The packing penetrated little more than an inch on either side, leaving the central portion of rail flange entirely unsupported. When the weight was brought on, the flange either bent or the packing was crushed, resulting in a loose rail after a short time. With the method previously mentioned a much better surface can be obtained, and sags and rolls in the original road surface can be taken out while the rails are being laid.

MAINTENANCE.—To avoid undue waste of current, regular attention should be paid to cleaning out the grooves of rails and watering the track. With heavy traffic, and probable corrugations in the surface of the rail a rail grinder is a necessity; but full benefit is not derived from its use if the joints are not secured. Where unusual street traffic is experienced, chilled cast-iron paving blocks may be laid, abutting on the rails alternately with granite.

TABLE I.—Allowance to be Made for Overhang of Ordinary Double-Deck Cars on Curves.

Radius of inner rail, ft.	Overhang, ft. ins.	Radius of inner rail, ft.	Overhang, ft. ins.
36	1 10½	80	0 9¾
38	1 8¾	90	0 8½
40	1 7¾	100	0 8
42	1 6¾	120	0 6½
44	1 6	140	0 5½
46	1 5	170	0 4¾
50	1 3¾	200	0 4
55	1 1	250	0 3
65	1 0	300	0 2½
70	0 11	400	0 2

TABLE II.—Extra Width for Standard Gage on Curves, with 6-ft. Rigid Wheelbase.

Radius of inner rail, ft.	Extra width, in.
35	3/16
40	9/64
45	7/64
50	3/32
60	5/64
70	1/16
80	3/64
100	1/32

A UNIVERSAL DICTIONARY OF MECHANICAL DRAWING.*

By George H. Follows.†

Part VI. Finishes and the Finish Mark.

78. In everyday English the word *finish* means "to complete." In workshops the same word has several other meanings; one of them—common in machine shops—is "to shape to dimensions with a cutting tool." It is perhaps unfortunate that custom has permitted the word to be used in this special sense, but it cannot be helped; and it is not likely that anything would be gained by an attempt to introduce a new word as a universal substitute, especially as *Face, Dress* and *Shape* are already used in some shops to mean the same thing. It is probably best to accept conditions as they are, and agree that the special meaning of the word shall hold.

79. Broadly speaking, any process by which a surface is completed is a finishing process, the result of which is a finished surface—or simply a "finish." It is part of the business of the draftsman to say what the nature of a finish shall be; it is not necessarily his business to state by what process a finish shall be obtained, but it is *essential* that the drawing shall indicate the finish itself—the *result*.

80. In this there is a principle involved: *A drawing should be made right to stay right*; which means, among other things, that it should as far as possible allow for changes in shop methods, so long as the results obtained are the same. There is an application of this principle in Part V, paragraph 70: "A change of material after a drawing has been made does not necessitate the erasing of a sectioning;" in other words, the sectioning is made right to stay right.

81. In the matter of finishes it is distinctly poor practice for a drawing to say how a result shall be obtained; for example: If it says "plane," and the shop "mills," the drawing is wrong. It is not possible to say exactly when and when not to specify a finishing process; sometimes it is necessary, but on principle it should be avoided, because unless it is agreed that a change of process shall be immediately followed by a change in every drawing that calls for the superseded process—which would be an unbearable hardship—drawings are liable at any time to become ineffective and misleading.

82. The finishes that it is necessary to specify in mechanical drawings can be divided into two general classes: (1) Tool finishes, produced by cutting or abraiding. (2) Coat finishes, obtained by coating with some preservative.

83. The following are a number of Tool Finishes with their definitions:

FINISH.—Shape to dimensions with a cutting tool. This calls for measured adherence to dimensions (either within limits as stated on the drawing, or as considered suitable by the shop); the surface to be such as good shop practice requires but not to have anything done upon it for mere appearance.

SPOT FINISH.—Finish a circular spot. This calls for measured adherence to dimensions, and can be done with a counterbar or similar tool.

SPOT FACE.—Face a circular spot. This does not call for measured adherence to dimensions; otherwise it is the same as spot finish.

TRIM.—Shape by any convenient means; as by chipping, filing, sawing, grinding, etc. This does not call for measured adherence to dimensions.

POLISH.—Make the surface smooth and glossy. Except when used in conjunction with "Finish," this does not call for measured adherence to dimensions nor for a perfectly true surface. It can be produced by such means as grinding and buffing.

GRAIN.—Give the material the appearance of having a straight grain; as by drawfiling or rubbing with emery cloth.

MATT.—Make the surface artistically rough. This can be done by direct hand work or, in the case of a casting, by covering the face of the pattern with pebble-surface paper.

84. These finishes with their definitions are intended to relieve the draftsman of responsibility and to place it on the shop where it rightly belongs. An example will show what this means: In a certain establishment, during a number of years, several hundred drawings were made specifying that certain holes should be "drilled." Today, by means of modern tools these holes are accurately punched; and now the drawings are wrong to stay wrong, for they will never be corrected; it would cost too much.

85. It is generally no affair of the draftsman's—or at least not necessary for the drawing to state—whether the shop will plane, mill, shape, bar, broach, drill, punch, chip, file, saw, grind, scrape, ream or how a result will be obtained. The drawing must, however, indicate required results; this is what the finishes given above are intended to do, without limiting the shop to any specified processes. The judgment of the draftsman should tell him when it is necessary or wise to specify

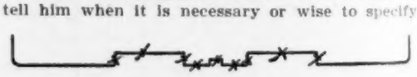


FIG. 17.

an actual process. In some cases the name of the finish is also the name of the process; "Knurl" is an example.

86. COAT FINISHES.—A great number and variety of finishes belong to this class; as paint, lacquer, varnish, shellac, French polish, Japan, electroplate, oxidize, boil in oil, etc. It is proper to designate these finishes by full descriptive name or by some well understood abbreviation of it.

87. THE FINISH MARK.—In drafting rooms it is common practice to mark with an "f" the bounding lines of surfaces that are to be "finished." Unfortunately this f, as a finish mark, easily degenerates into an untidy scrawl; it is too readily scribbled, and when applied as in Fig. 17—which is an example from an existing working drawing—it is altogether unsatisfactory.

88. The finish mark presented in Fig 18 was the outcome, some five years ago, of an effort to

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find something better than the f. It possesses the advantage of pointing to instead of cutting the line; it has a distinct individuality and is very visible, it is easy to draw but difficult to scribble, and the special application of it for broken surfaces is decidedly valuable.

ENGINEERING MATERIAL PRICES.

TRACK FASTENINGS—
New York—at mill—Angle bars, 1.40 to 1.50 cts.; spikes, 1.70 to 1.75 cts.; bolts, square nuts, 2.15 cts.; bolts, hexagonal nuts, 2.40 cts.

RAILS, STEEL—
New York—at mill—New standard sections, $28; standard, second quality, $27; light sections, 12 to 25 lbs., $24 to $26; old iron, f. o. b. New York, $21 to $22; old steel, long lengths, $14.50 to $15; old steel, short pieces, $14 to $14.50; relayers, $22.50 to $23.
Pittsburg—Standard sections, at mill, $28; light rails, at mill, $24 to $27; old steel rails, $14 to $15.

STRUCTURAL MATERIALS—
New York—at tidewater—Beams and channels, up to 15-in., 1.84½ cts.; over 15-in., 1.84½ cts.; angles, 3 × 2 and up to 6 × 6, 1.84½ cts.; zees and tees, 1.89½ cts.; steel bars, half extras, 1.74½ cts.

PLATES AND SHEETS—
New York—at tidewater—Sheared plates, tank, 1.74½ to 1.84½ cts.; flange, 1.84½ to 1.94½ cts.; marine, 1.94½ to 2.04½ cts.; still bottoms, 2.04½ cts.; fire box, 2.24½ to 3.05 cts.
Pittsburg—Tank, ¼-in. thick and heavier, 1.60 cts.; black sheets, 27 gage, 2.20 to 2.25 cts.; black sheets, 28 gage, 2.25 to 2.30 cts.

IRON—
Pig Iron:
New York—tidewater—No. 1 X Foundry, Northern, $16.25 to $16.75; No. 2 X Foundry, Northern, $15.75 to $16.25; No. 2 Plain Foundry, $15.50 to $15.75; Gray Forge, Northern, $14.25 to $14.75; Basic, Northern, $15 to $15.25; Basic, Alabama, $15.75; Basic, Virginia, $15.75 to $15.80; No. 1, Virginia Foundry, $17.10 to $17.60; No. 2 Virginia Foundry, $16.35 to $16.60; No. 1 Foundry, Southern, $16.25; No. 2 Foundry, Southern, $15.50 to $15.75; No. 3 Foundry, Southern, $15.25; No. 4 Foundry, Southern, $14.60 to $14.75; No. 1 Soft, Southern, $16.75; No. 2 Soft, Southern, $15.50 to $15.75; Gray Forge, $14 to $14.25; Mottled, $13.75 to $14.
Pittsburg—f.o.b. cars—No. 2 Foundry, $15.35; Gray Forge, $14.25 to $14.50; Bessemer Iron, $14.85 to $15.35; Ferro Manganese, $48.50 to $49; Muck Bars, $27.35 to $28; Iron Bars, $1.50 to $1.60.
Cast-Iron Pipe:
New York—Carload lots, net tons, 6-in., at tidewater, $27.
Chicago—4-in. water pipe, $29; 6-in. and larger, $28, with $1 extra for gas pipe.

MISCELLANEOUS MATERIALS—
Asphaltum:
Ventura and other California asphalts, $20 to $21 per ton at New York; Trinidad refined, $25 to $30 per ton; Venezuela asphalt, $25 to $30 per ton; Bermuda asphalt, $25 to $30.
Cement:
Rosendale 85 cts.; Portland domestic, in sacks, $1.13 to $1.15; in wood, $1.45; German Portland, $2.45 to $2.80.
Copper:
Lake, 16.25 to 16.75 cts.; electrolytic, 16.25 to 16.75 cts.; casting, 15.87½ to 16.37½ cts.
Lead:
New York, spot, 4.85 to 4.90 cts.
Spelter:
New York, spot, 5.75 to 5.85 cts.
Tin:
New York, spot, 32.40 to 32.50 cts.
Tar:
New York, $6 per bbl.
Pitch:
New York, $2.80 to $2.85.

LUMBER—
New York, wholesale prices:
Piling—Spruce, ordinary cargoes, 6 to 7 cts.; oak, 14-in. butt, 40 to 50 ft., 19 cts.; 50 to 55 ft., 22 cts.; 55 to 60 ft., 23 cts.; 60 ft. and up, 25 cts.; pine, 60 to 65 ft., $8.50; 70 to 75 ft., $10.50; 80 ft. and up, $16.
Railroad ties—Yellow pine, 6 × 9 ins. × 8 ft., 62 to 63 cts.; 6 × 8 ins. × 8 ft., 57 to 58 cts.; 7 × 9 ins. × 8 ft., 72 to 73 cts.; 7 × 8 ins. × 8½ ft., 68 to 70 cts.; 7 × 9 ins. × 8½ ft., 73 to 75 cts.

Bids for the final disposition of the garbage of Manhattan Borough, New York City, for the five years beginning Aug. 1, 1906, are now being invited by Major John McG. Woodbury, Commissioner of Street Cleaning, Park Row Building, New York. As the bids will not be opened until Nov. 6 ample time is afforded contractors to prepare the "complete plans and specifications" which must be submitted with their bids. Under the proposed contract the city will deliver the garbage to the water-front dumps of the street cleaning department, which dumps will not exceed ten in number and will be located on the North, Harlem and East Rivers. The contractor must receive the garbage in scows or other conveyances and remove it from the water front at least once in 24 hours. The plant for the final disposition of the garbage must have a capacity of at least 1,000 tons a day. For the information of bidders, however, it is stated that during the last five years there has been delivered to the present contractor for garbage disposal an average of 158,845 tons a year, as follows: 1900, 138,207 tons; 1901, 122,419; 1902, 167,733; 1903, 184,349; 1904, 181,515. Counting 313 working days to a year the average daily removal for the five years was about 510 tons. The bids are to be made on a lump sum, yearly basis, regardless of the quantity of garbage delivered by the city. In general, the means of transportation, final disposal and location of the disposal works are left to prospective bidders, but full information on all these points must accompany each bid; and the contractor must agree to heed all local, State and National laws bearing upon the dumping and the final disposition of garbage. The garbage must "be disposed of in a manner not prejudicial to the public health and the process employed by the contractor is to be not only noisome in its operations, but also to be effective as to final results." No culling or sorting of garbage at the department docks will be permitted.

The Commissioner reserves the right to select from the various proposals the one "which will, in his judgment,

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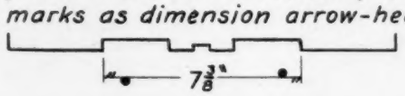
THE FINISH MARK: √ Drawn freehand. Consists of a thin, straight pointer line, with two medium-weight barbs on one side of the line and a circular head on the other side.
SIZE: The standard is $\frac{3}{16}$" — √ but this should be varied to suit the character of the drawing and the space available.
MANNER OF CONSTRUCTING: First draw the pointer line; add the barbs; finish with the head.

CONSTRUCTION IN FOUR STEPS

ORDINARY APPLICATION: Apply to the bounding line of the surface at an angle of 3 in 8, as in the following examples: The barb should always be in the obtuse angle formed by the pointer line and the line of surface, never thus: √

EXAMPLES OF APPLICATION

SPECIAL APPLICATION: When a surface is of such a shape as to naturally require several finish marks inconveniently close together, indicate the extent of the finish by using two marks as dimension arrow-heads, thus:



This means that the entire surface between the projection lines is to be finished. Compare this with Fig. 17.

CONJUNCTIONS: Sometimes it is necessary to specify a double finish, as "Finish and Polish." The mark can then be used in conjunction, thus:

Polish — Grain — Scrape

It is often advisable to specify a finish by means of a note, as Finish all over: Trim flush with edge of flange: Finish and Polish from A to B: Polish exposed surfaces: Grain parallel to edge C D.

FIG. 18. THE FINISH MARK

best secure the efficient performance of the work." At or at any time within three months after the termination of the contract the city is to have the right to buy the contractors' scows and also his works for the final disposal of garbage at a price either mutually agreed upon or else determined by arbitration.

THE BOILER EXPLOSION ON THE "BENNINGTON," which was subjected to the investigation of a Board of Inquiry whose report was noted in our issue of Aug. 24, has been reviewed, on the basis of that Board's findings, by Secretary of the Navy Bonaparte. The Secretary directs that Commander L. Young, in command of the vessel, and Ensign Charles T. Wade, in charge of the vessel's machinery, be brought to trial by court-martial on charges of neglect of duty. The Board of Inquiry had recommended such action in the case of Ensign Wade, for neglect of duty in not having the safety and sentinel valves of the boilers inspected, tested and kept in proper condition. The Secretary's finding extends this charge to cover the condition of the boilers generally. The Board had found that the boilers were in "fair condition and efficient, considering their age," which finding the Secretary holds to be erroneous in view of the condition of the safety valves. The report of the Board made no reference to the commander of the vessel, but the Secretary holds that, as the commander is responsible for the discipline on and the condition of the vessel, and the boilers and their proper care are parts thereof, a prima facie case of neglect of duty lies against him, of which he must be required to clear himself before a court-martial.

A RAILWAY WRECK IN ENGLAND caused the death of 10 persons on Sept. 1. A passenger train outbound from London on the Great Eastern Ry., was derailed close to Witham station and thrown against the station platform.

PERSONALS.

Mr. I. Austin Miller has been appointed City Engineer of Houston, Tex., succeeding Mr. F. L. Dormant.

Mr. W. S. Newhall has resigned his position as Chief Engineer of the Wabash Ry. This resignation was noted last week, but his name was incorrectly spelled.

Mr. F. H. Snow, M. Am. Soc. C. E., has been appointed to a position as head of the Sanitary Engineering Division of the Pennsylvania Department of Health.

Mr. W. A. James has been appointed engineer in charge of the double tracking and grade revision of the Canadian Pacific Ry. between Winnipeg and Fort William.

Mr. E. H. Pfafflin has been appointed Engineer of Way and Structures of the Southern Indiana Ry., with office in the Grand Central Station, Chicago, to succeed Mr. F. W. Ranno, resigned.

Mr. Frank Lee has been promoted from Assistant Engineer of the Western Division to Division Engineer of the Central Division of the Canadian Pacific Ry., with headquarters at Winnipeg.

Mr. Anthony E. Steere has resigned his position as Engineering Aid in the U. S. Reclamation Service, to accept an appointment in the New York State Service and reports to Mr. Willis, Division Engineer at West Waterford, N. Y.

Mr. H. M. Stout, senior instructor in civil engineering in the Worcester Polytechnic Institute, was recently appointed Assistant Engineer of The Rutland R. R., New York Central Lines, and was assigned to the Chatham Division, with headquarters at Chatham, N. Y.

Mr. B. H. Warren retired from the Presidency of Allis-Chalmers Co., of Milwaukee, Sept. 1, and it is understood that he will become the head of a new engineering and contracting company which is being formed in New York in association with a number of powerful interests.

Mr. Duncan MacPherson, whose resignation as Division Engineer of the Canadian Pacific Ry. was noted last week, has been appointed Assistant Chief Engineer for the Transcontinental Railway Commission which will build the government section (Moncton to Winnipeg) of the new Canadian transcontinental railway.

Mr. R. W. Christian, a mining engineer, well-known as a gold dredge operator and inventor, has entered into a contract with the Allis-Chalmers Co., by which that company obtains exclusive rights to his patents, and also to his services as engineer in designing and constructing gold dredges which the company may make embodying his inventions.

Mr Geo. P. Low, founder of the "Journal of Electricity, Power and Gas," San Francisco, Cal., and who has for the past 16 months occupied its editorial chair, has resigned therefrom and will hereafter devote himself to the preparation of descriptive articles relating to engineering machinery, processes, plants and properties. His address will be 237 Cherry St., San Francisco, Cal.

Mr. E. G. Howard, Assoc. Am. Inst. E. E., has resigned his position as Electrical Engineer for the Chapman Valve Co. and will accept a similar office with the Coffin Valve Co., Boston, Mass., early in September. Mr. Howard has been identified with the Chapman Valve Co. for the past four years, having been engaged on the development and placing on the market of valves operated by electricity.

Mr. W. Wyssling, of Zurich, Commissioner of the Swiss Government for electric railway studies and Mr. Charles Wirth, of Berne, a Government Engineer, are now in this country, for the purpose of studying electric railway methods. The Government of Switzerland has planned to apply electricity to all of the State-owned railway lines, and to operate these roads from water power plants, utilizing the mountain streams as a source of energy.

Hon. James H. McColl, a member of the Australian Parliament and a citizen of the State of Victoria, is visiting the United States for the purpose of studying the irrigation institutions and practices of this country for the benefit of irrigated agriculture in Australia. As Mr. McColl can visit but relatively few of the many people who would doubtless be glad to give him information, he has prepared a list of questions which will be forwarded to volunteers who address Mr. Elwood Mead, M. Am. Soc. C. E., Chief of Irrigation and Drainage Investigations, U. S. Department of Agriculture, Washington, D. C. In return for courtesies shown him Mr. McColl will gladly forward information on kindred subjects as related to Australia.

Changes in the instructional staff of the Engineering Department of Purdue University have been announced. The appointments, effective Sept. 1, are as follows:

Mr. C. P. Matthews, M. E., Ph. D., M. Am. Inst. E. E., for several years past Professor of Electrical Engineering, Purdue University, has been appointed Director of the Electrical Laboratory and in charge of the School of Electrical Engineering.

Mr. W. O. Teague, B. S. Massachusetts Institute of Technology, Department of Marine Engineering, two years with the Fore River Ship Yard, and one year with the General Electric Company, has been appointed Assistant Professor of Experimental Engineering, in charge of the Engineering Laboratory.

Mr. Albert Smith, B. S. Dartmouth College, C. E. Thayer School of Engineering, M. Western Soc. Engrs., has been appointed Assistant Professor of Civil Engineering.

Mr. G. A. Young, B. S., M. E., Assistant Professor of Mechanical Engineering, will hereafter be responsible for the direction of the work in thermodynamics.

Mr. F. R. Swift, B. S., Massachusetts Institute of Technology, 1901, for two years instructor in that institution and more recently with the General Electric Co., has been appointed Instructor in Mechanical Engineering.

Mr. O. C. Klipsch, B. S., Purdue University, 1901, since graduating with the Lake Shore & Michigan Southern Ry., has been appointed Instructor in Mechanical Engineering.

Mr. Arthur B. Smith, B. S., University of Nebraska, 1901, Assoc. M. Am. Inst. E. E., for a time Local Manager of telephone exchange, Nebraska Telephone Co., Tecumseh, Neb., afterwards Assistant Manager, Woodbine Telephone Co., Woodbine, Ia., and more recently Wire Chief and Engineer, Amsterdam Automatic Telephone Co., Amsterdam, N. Y., has been appointed Instructor in Telephone Engineering.

Mr. Parker E. Marean, A. M., B. S., Harvard University, has been appointed research assistant to Mr. W. F. M. Goss, succeeding Mr. Aldrich Durant who has been appointed an Assistant at Harvard University.

Mr. W. P. Heck, B. S., State College of Pennsylvania, 1904, recently with the Westinghouse Electric Co., has been appointed Assistant in the Engineering Laboratory.

Mr. J. W. Swearengen, B. S., Purdue University, 1904, since graduating with the General Electric Co., has been appointed Assistant in the Engineering Laboratory.

Mr. H. H. Scofield, M. E., Sibley College, Cornell University, 1905, has been appointed Assistant in the Engineering Laboratory.

Mr. H. S .Dickerson, B. S., University of Michigan, 1905, has been appointed Assistant in the Engineering Laboratory.

Mr. T. T. Eyre, B. S., Purdue University, 1905, has been appointed Assistant in Machine Design.

Mr. G. W. Case, B. S., Purdue University, 1905, has been appointed Assistant in Civil Engineering.

Mr. Walter Ackerman, B. S., Purdue University, 1905, has been appointed Assistant in Civil Engineering.

Withdrawals from the staff as organized during the last year have been announced as follows:

Mr. W. E. Goldsborough, Professor of Electrical Engineering, in charge of the Department, to become Assistant to the President of the J. G. White Co.

Mr. J. C. Kelsey, Professor of Telephone Engineering, to go with the Kellogg Switchboard and Supply Co.

Mr. G. E. Waesche, Assistant Professor of Civil Engineering, to undertake private work in engineering construction.

Mr. J. R. McColl, Associate Professor of Steam Engineering, to take up the work of Chief Engineer for the American Blower Co.

Mr. E. E. Reynolds, Associate Professor of Experimental Engineering, to devote himself to personal affairs.

Mr. N. J. Wheeler, Assistant in Engineering Laboratory, to become Associate Professor of Civil Engineering, University of Kansas.

Mr. R. R. Mitchell, Assistant in the Engineering Laboratory, to go with the Chicago Edison Co.

Mr. R. V. Brewster, Assistant in Civil Engineering.

Obituary.

Archer C. Stites, M. Am. Soc. C. E., died Aug. 27 at Monteagle, Tenn. In several years he was the western representative of the Phoenix Bridge Co., and later associated with Joseph T. Ryerson & Son.

E. W. Seymour, a contractor and builder of Binghamton, N. Y., died there Sept. 3 as the result of injuries received in falling from a lumber pile on the previous Tuesday.

William E. Stone, an architect, with offices at 35 Broadway, New York, was struck by a train at Princeton Junction Aug. 25 and was instantly killed.

Theodore W. Daley, a contractor and builder of Middletown, N. Y., and formerly a Building Inspector in New York City, died suddenly Aug. 23 at Goshen, N. Y., of heart disease.

ENGINEERING SOCIETIES.

COMING MEETINGS.

ROADMASTERS & MAINTENANCE OF WAY ASSOCIATION.
Sept. 12, 14. Annual meeting at Niagara Falls, N. Y. Secy., C. E. Jones, C., B. & Q. Ry., Beardstown, Ill.

NEW ENGLAND WATER-WORKS ASSOCIATION.
Sept. 13 to 16. Annual convention at New York, N. Y. Secy., Willard Kent, Narragansett Pier, R. I.

AMERICAN ELECTROCHEMICAL SOCIETY.
Sept. 18 to 20. Annual meeting at Bethlehem, Pa. Secy., S. S. Sadtler, 39 S. 10th St., Philadelphia, Pa.

AMERICAN PUBLIC HEALTH ASSOCIATION.
Sept. 25 to 29. Annual meeting at Boston, Mass. Secy., Dr. Chas. O. Probst, Columbus, O.

AMERICAN STREET RAILWAY ASSOCIATION.

AMERICAN RAILWAY MECHANICAL AND ELECTRICAL ASSOCIATION.

STREET RAILWAY ACCOUNTANTS' ASSOCIATION.
Sept. 25-30. Annual convention at Philadelphia, Pa. Secy., T. C. Penington, 2020 State St., Chicago, Ill.

ASSOCIATION OF RAILWAY SUPERINTENDENTS OF BRIDGES AND BUILDINGS.
Oct. 17. Annual meeting at Pittsburg, Pa. Secy., R. F. Patterson, Concord, N. H.

MAINTENANCE OF WAY MASTER PAINTERS' ASSOCIATION.
Nov. 13, 14. Annual meeting at Cincinnati, O. Secy., H. J. Schnell, 100 William St., New York, N. Y.

WESTERN SOCIETY OF ENGINEERS.—The award of the three Chanute medals for the best papers presented by members during the year 1904, has been announced, as follows: 1, Civil engineering, to Mr. W. A. Shaw for his paper descriptive of part of "The Intercepting Sewers of Chicago." 2, Mechanical engineering, to Mr. A. Bement for his paper on "Lane Boiler Performance with Chain Grate Stokers." 3, Electrical engineering, to Mr. Geo. A. Damon for his paper on "The Opportunities in the Electrical Business."

NEW ENGLAND WATER-WORKS ASSOCIATION.—The full program for the twenty-fourth annual convention, to be held at New York City on Sept. 13 to 16, inclusive, has been issued and may be obtained from the secretary. It gives particulars about excursions, etc., which feature is fully provided for. The headquarters during the meeting will be at the Murray Hill Hotel. Technical sessions will be held at 9.30 a. m., and 2.30 p. m. of Wednesday, Sept. 13, 9.30 a. m. Thursday, 9.20 a. m., and 8 p. m. Friday Sept. 15. The reports and papers to be presented are as follows, in the order of reading: Report of committee on Meter Rates, by Freeman Coffin, of Boston, Mass.; Report of Committee on Private Fire Services, by F. H. Crandall, of Burlington, Vt.; "Fire Service Meters," by E. V. French, of Boston, Mass.; Report of committee on Uniformity of Hose and Hydrant Threads, by G. A. Stacy, of Marlboro, Mass.; "Water-Works Accounting," by J. F. J. Mulhall, of Boston, Mass.; "The Water Softening Plant at Oberlin, O.," by W. B. Gerrish, Oberlin, O.; "The Relation of Intensity of Typhoid Fever to Character of Water Carriage," by Prof. W. P. Mason, of Troy, N. Y.; "The Use of Copper Sulphate as an Algicide," by G. T. Moore, of Washington, D. C.; "The Use of Copper Sulphate to guard against Typhoid Fever Epidemics coming from Unfiltered Surface Water Supplies," by Prof. W. P. Mason, of Troy, N. Y.; "Destruction by Copper Sulphate of Typhoid Fever Germs," by D. D. Jackson, of Brooklyn, N. Y.; "Germicidal Properties of Metallic Copper," by Prof. H. Kraemer, of Philadelphia, Pa.; "Toxicological Aspects of the Copper Sulphate Treatment," by Prof. H. E. Smith, of New Haven, Conn.; "Copper Sulphate in Connection with Water Filtration," by H. W. Clark, of Boston, Mass.; "Concerning the Behavior and Uses of Copper Sulphate in the Purification of Hard and Turbid Waters," by J. W. Elims, of Cincinnati, O.; "The Application of Copper Sulphate to the Effluents of Coarse-grained Sewage Filters," by G. A. Johnson, Columbus, O.; "Some Features of Estimating Stream Flow in New England," by H. K. Barrows, of Boston, Mass.; "The Water Supplies of the New York Metropolitan District and Vicinity, with Special Reference to their Purification," by G. C. Whipple, of New York, N. Y. Secy., Willard Kent, Narragansett Pier, R. I.

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